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TM 9-1825A

WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept. of Army

ORDNANCE MAINTENANCE

ELECTRICAL EQUIPMENT

(DELCO-REMY)



WAR DEPARTMENT

12 JANUARY 1944

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ORDNANCE DEPARTMENT
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12 January 1944

***This manual supersedes TB 1750D-1, 29 March 1943.**

WAR DEPARTMENT
Washington 25, D. C., 12 January 1944

TM 9-1825A, Ordnance Maintenance: Electrical Equipment (Delco-Remy), is published for the information and guidance of all concerned.

[A. G. 300.7 (30 Nov. 43)]

BY ORDER OF THE SECRETARY OF WAR:

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DISTRIBUTION: R 5 and 9 (4); Bn 5 and 9 (2); C 5 and 9 (5)

(For explanation of symbols, see FM 21-6)

ORDNANCE MAINTENANCE ELECTRICAL EQUIPMENT (DELCO-REMY)

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CHAPTER 1

INTRODUCTION

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1. SCOPE.

a. The instructions contained in this manual are for the information and guidance of personnel charged with the maintenance and repair of Delco-Remy electrical equipment. These instructions are supplementary to field and technical manuals prepared for the using arms. This manual does not contain information which is intended primarily for the using arms, since such information is available to ordnance maintenance personnel in 100-series TM's or FM's.

b. This manual contains a description of, and procedure for disassembly, inspection, repair, assembly, and test of Delco-Remy electrical equipment used on ordnance applications.

2. CONTENTS AND ARRANGEMENT OF MANUAL.

a. The chapters in the manual deal with the various electrical units used on ordnance applications. Thus, chapter 2 covers Generators; chapter 3, Regulators, and so on, as listed in the table of contents. Each chapter is broken down into sections, which deal with various constructions and designs of the electrical unit covered in the chapter. Thus, chapter 2, Generators, is divided into five sections, the first of which is general. Section II covers third-brush standard-duty generators; section III covers Shunt, standard-duty generators; section IV covers Third-brush, heavy-duty generators, while section V covers Shunt, heavy-duty generators. The specifications for each type of generator are covered in the particular section that deals with that type generator. All other chapters are similarly arranged.

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**CHAPTER 2
GENERATORS**

Section I

BASIC PRINCIPLES OF OPERATION

	Paragraph
Construction	3
Function	4
Wiring circuits	5
Control of output	6

3. CONSTRUCTION.

a. The generator is a machine used to convert mechanical energy into electrical energy. The generator is so mounted as to be driven by the engine, and it uses some of the mechanical energy from the engine to create electrical energy. The generator consists of a field frame with field coils which produce a magnetic field, an armature to support

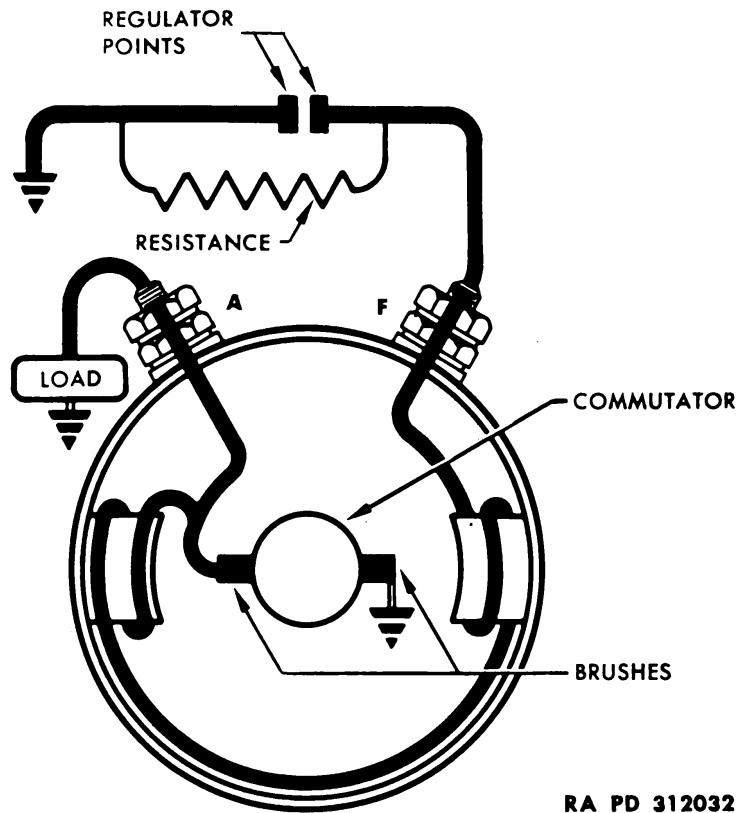


Figure 1—Type One Generator—Externally Grounded Field Circuit

BASIC PRINCIPLES OF OPERATION

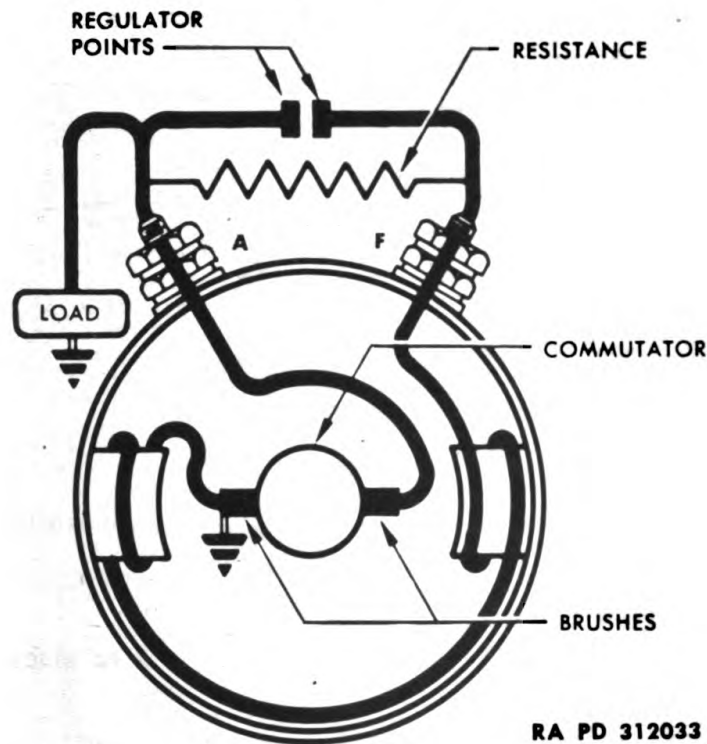


Figure 2—Type Two Generator—Internally Grounded Field Circuit

conductors in and rotate conductors through the magnetic field, a commutator on the armature and stationary brushes on the commutator end head to carry away current induced in armature conductors, and bearings to support the armature.

4. FUNCTION.

a. The generator has two jobs. It restores to the battery the current withdrawn during cranking, thus maintaining the battery in a charged condition. Secondly, it carries the connected electrical load up to the capacity of the generator, when the generator is operating at speeds at which substantial or maximum generator output is available, thus preventing undue or prolonged draining of the battery.

5. WIRING CIRCUITS.

a. Generators are connected internally in two different ways. It is necessary to understand the two types of wiring circuits, because each type has its own checking procedure. The checking procedure for type one does not apply to the checking procedure for type two.

b. Generator output is controlled by varying the field strength. In third-brush generators the third brush is shifted toward or away from a main brush to increase or lower the field strength and thus increase or lower generator output. In shunt generators (and on many

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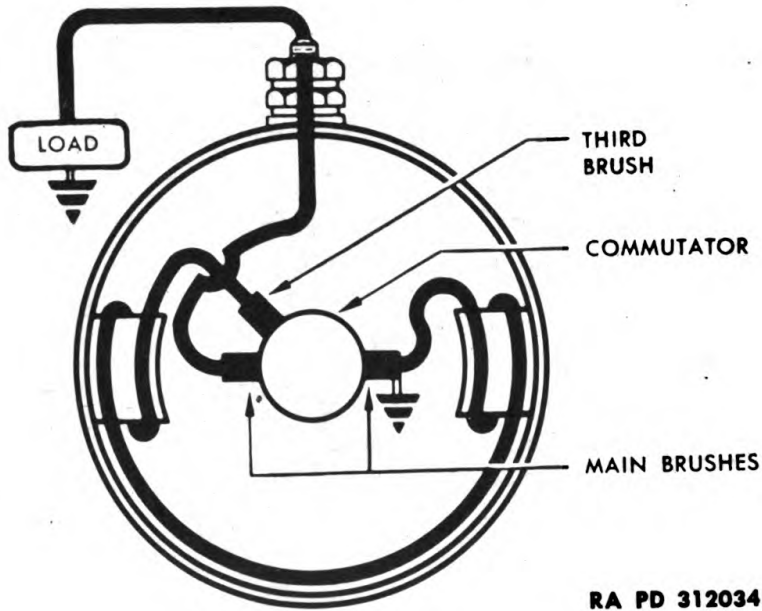


Figure 3—Third-brush Generator Wiring Circuit

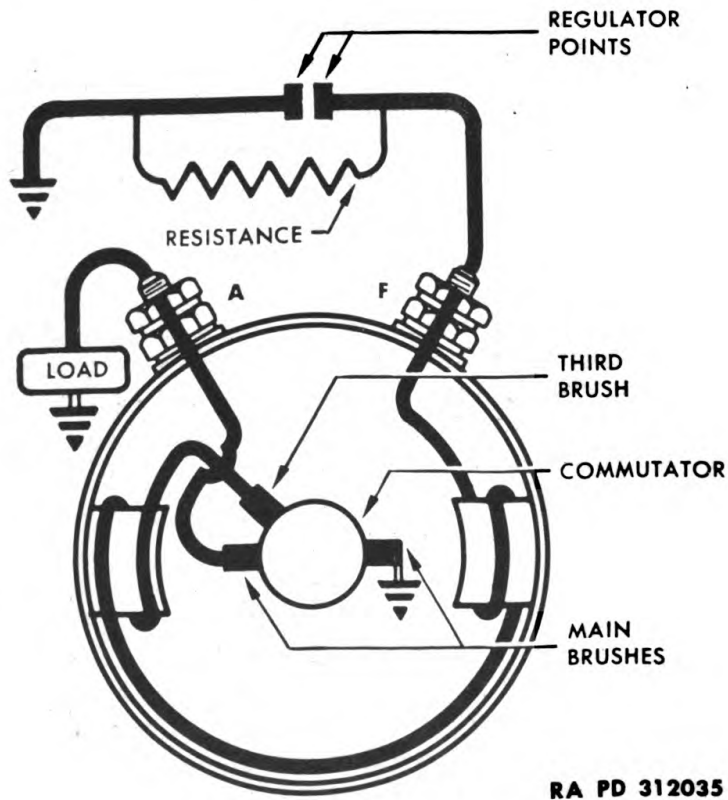


Figure 4—Third-brush Generator Using External Regulation

BASIC PRINCIPLES OF OPERATION

third-brush generators) the field strength is varied by inserting or removing resistance in the generator field circuit. Inserting resistance reduces field strength, cuts down generator output. Removing the resistance increases field strength, permits increased generator output.

c. The part of the circuit in which the resistance is inserted determines whether the generator is type one or type two. Figure 1 illustrates a simplified wiring circuit for type one generator. The field circuit is connected inside the generator to the insulated brush. Outside the generator, the other end of the field circuit is connected to ground (the return circuit) through a resistance, or through a set of points. The resistance and set of points are in the regulator, the operation of which will be detailed in chapter 3.

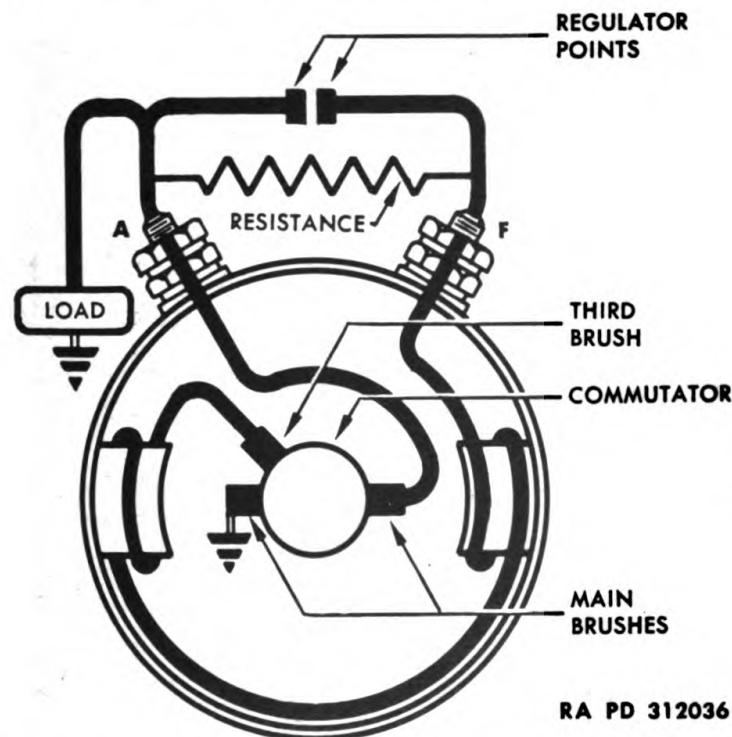


Figure 5—Type Two Third-brush Generator with External Regulation

d. Figure 2 illustrates a simplified wiring circuit for type two generator. The field circuit is connected inside the generator to the grounded brush. Outside the generator, the other end of the field circuit is connected to the insulated brush through a resistance or through a set of points.

e. Since the field circuit of type one generator is normally insulated inside the generator (when used with external control or regulator), while the field circuit of type two generator is normally grounded inside the generator, two different checking procedures are required in checking the generators.

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6. CONTROL OF OUTPUT.

a. While the control of generator output is usually divided into two groups for discussion, third brush and external controls, both actually operate on the same principle. This principle is that increasing the generator field strength increases generator output, while lowering field strength reduces the output. Figure 3 illustrates a simplified circuit of a third-brush generator of type one. It is classified as type one because, when used with external regulation, the grounded side of the field circuit is brought out of the generator (fig. 4). The third-brush generator can also be connected so as to be classi-

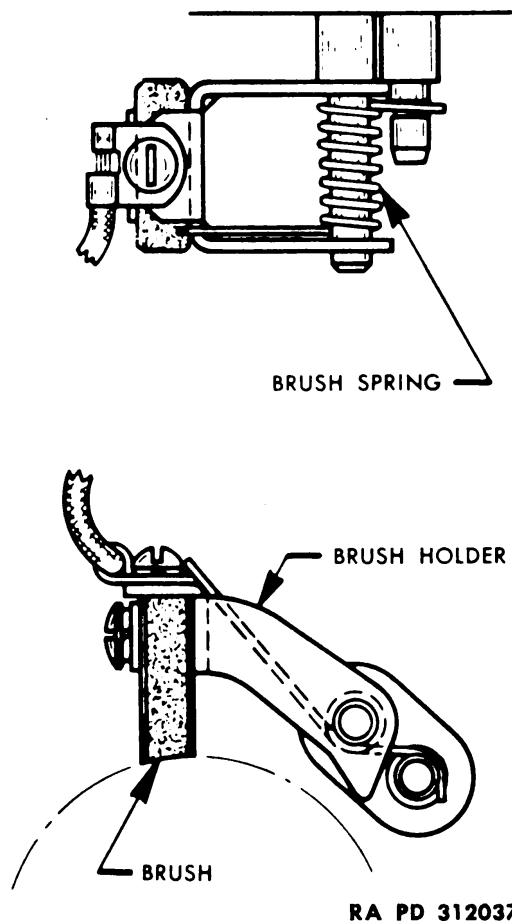


Figure 6—Swivel-type Brush Holder

fied as a type two generator (fig. 5). In this system, the third brush is positioned near the grounded brush instead of the insulated brush, and consequently has the same polarity as the grounded brush.

b. The third brush can be used to control generator output by shifting it toward or away from the adjacent main brush. The main brushes are placed in such a position that full generator voltage is imposed on them. The third brush is back of this position. If the third brush is moved closer to the main brush, it picks up a greater per-

BASIC PRINCIPLES OF OPERATION

centage of the total voltage, thus increasing the generator field strength. This causes a higher output. If the third brush is moved away from the main brush, it picks up less of the total voltage, decreasing generator field strength and generator output.

c. The external regulator operates by inserting resistance into the generator field circuit (figs. 1 and 2) to reduce field strength and generator output. The regulator does not permit the generator to produce a higher output than a generator without a regulator. It merely reduces generator output when full output is not required by the electrical system.

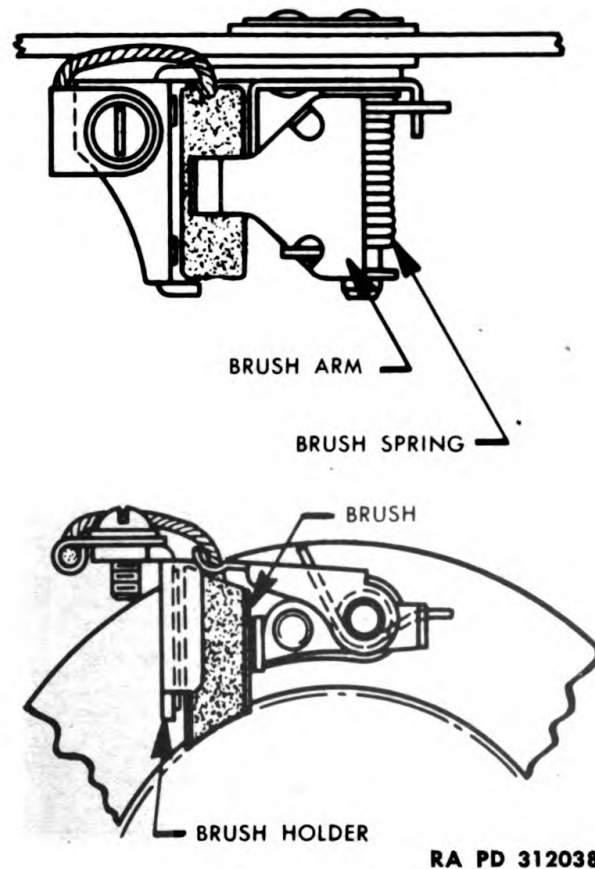


Figure 7—Reaction-type Brush Holder

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CHAPTER 2
GENERATORS (Cont'd)

Section II

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

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Cleaning, inspection, and test	8
Disassembly	9
Cleaning, inspection, and test of parts	10
Repair of parts	11
Assembly of generator	12
Tests and adjustments	13
Test data and tolerances	14

7. DESCRIPTION.

a. The generators in this group are all third-brush type one generators, either with or without a cut-out relay or step-voltage

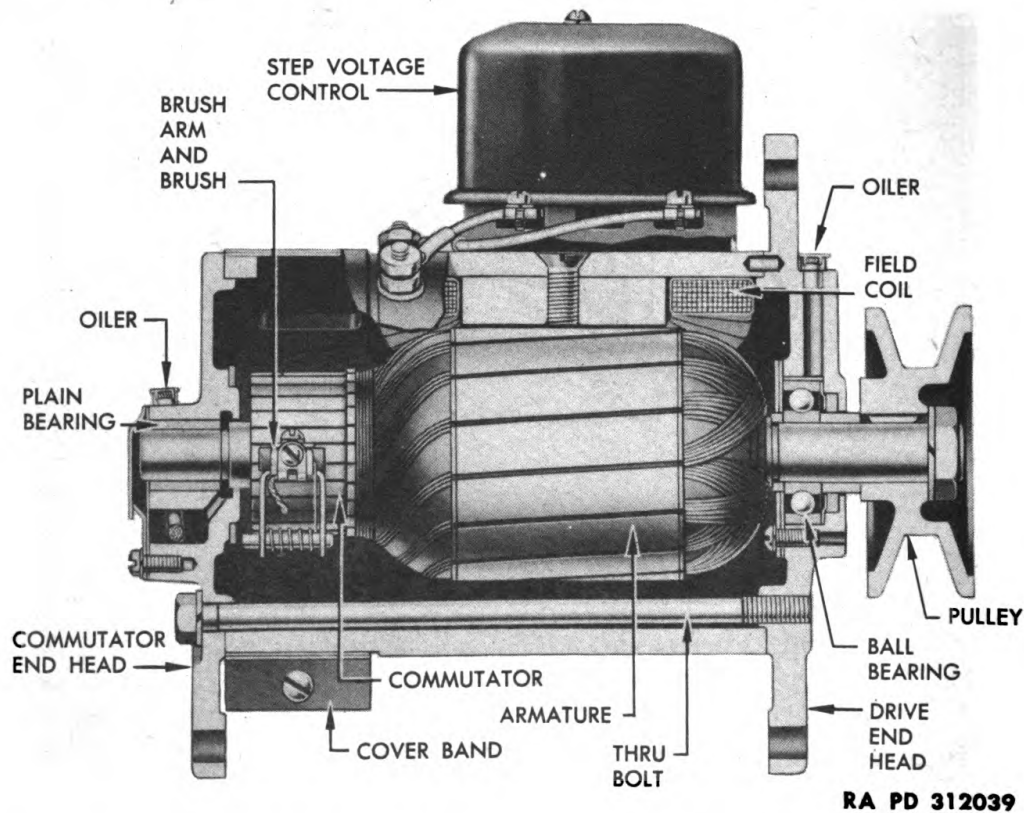
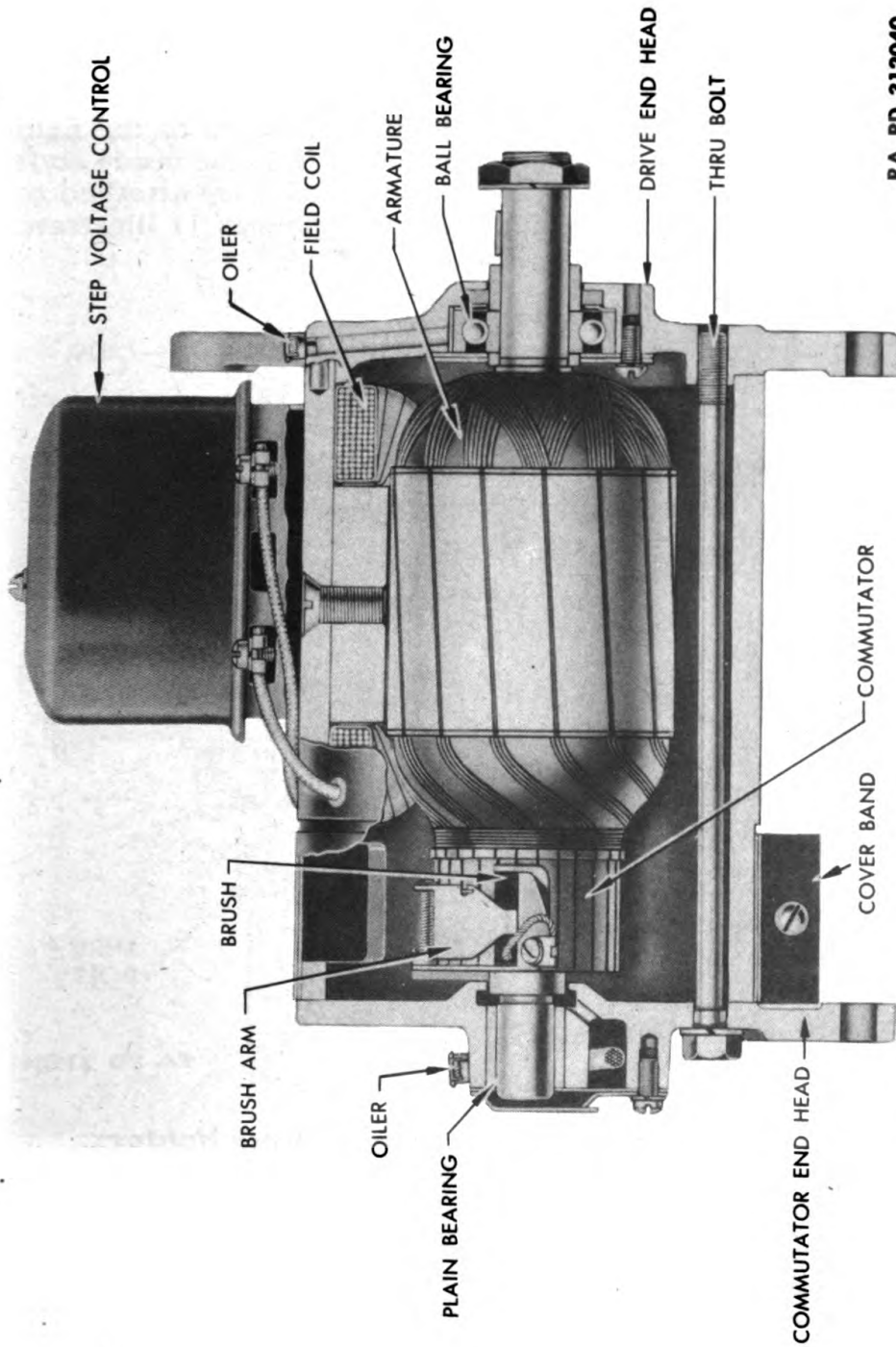


Figure 8—Generator with Swivel-type Brush Holders, Terminal Studs, and Step-voltage Control

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

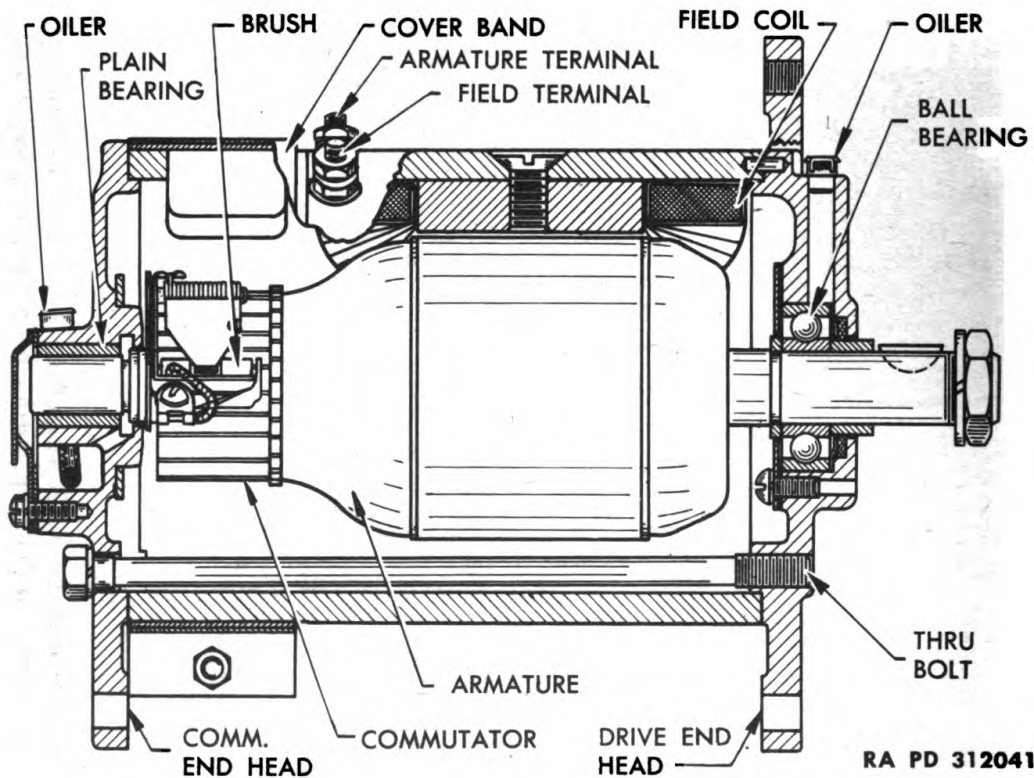


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Figure 9—Generator with Reaction-type Brush Holders, Insulating Bushings in Field Frame, and Step-voltage Control

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control mounted on the frame. The generator may use either a swivel type brush holder (fig. 6) or a reaction type holder (fig. 7). All of these generators have a ball bearing in the drive end to support the armature, and some have a ball bearing in the commutator end. Others have a plain bearing in the commutator end. Some generators have insulating bushings in the field frame through which leads pass from the brush holders to the step-voltage control or cut-out relay terminals. Others have terminal studs that are attached to the field frame with insulating bushings. Leads are soldered to the inside ends of the studs, while the leads from the control or relay are attached to the studs by clips, washers and nuts. Figures 8 through 11 illustrate these variations.



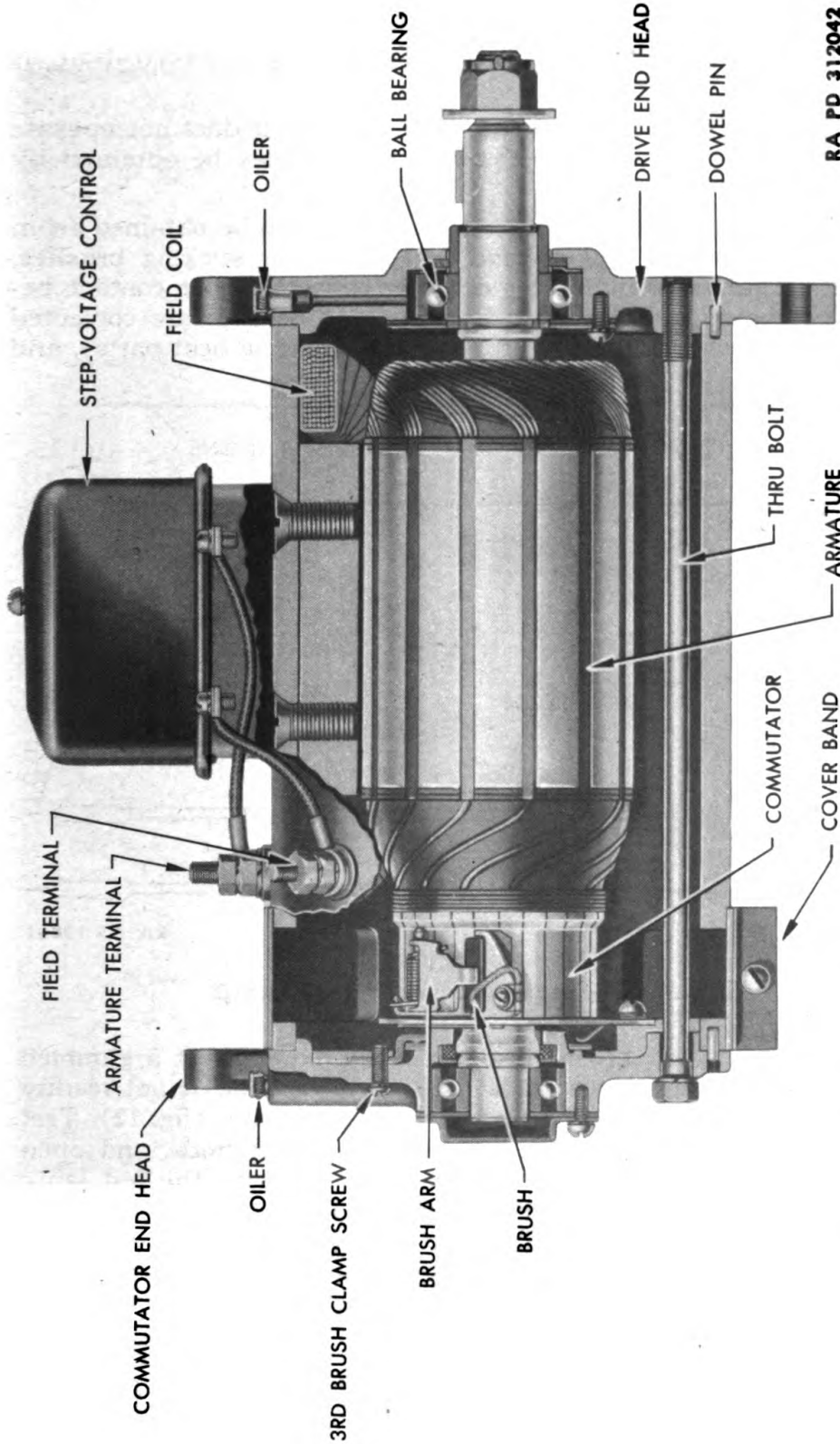
**Figure 10—Generator with Reaction-type Brush Holders,
and Terminal Studs**

8. CLEANING, INSPECTION, AND TEST.

a. Cleaning. Wipe off excess grease and dirt with a clean cloth. Do not steam-clean or dip-clean the generator, and avoid getting any water or cleaner in the generator. Handle generators carefully to avoid battering or bending terminal studs, cover band, relay or control unit (where mounted on generator).

b. Inspection. Inspect the generator for damage. Remove cover band and inspect for sticking or worn brushes, rough, out-of-round,

GROUP I-THIRD-BRUSH, TYPE ONE GENERATORS



RA PD 312042

Figure 11—Generator with Reaction-type Brush Holders, Terminal Studs, Step-voltage Control, and Ball Bearings

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dirty or burned commutator, or high mica on commutator. Inspect all visible connections, screws, insulators, terminal studs, leads and washers. Any apparent defect requires disassembly and correction, as outlined below.

c. **Test.** Place generator on the test stand. If it does not operate correctly, some idea as to the cause of trouble may be obtained by checking further.

(1) **NO GENERATOR OUTPUT.** If no output can be obtained from the generator, remove cover band and check for sticking brushes, gummed or burned commutator or other causes of poor contact between the commutator and brushes. Sticking brushes are corrected by cleaning brush holders and brush arms (replacing bent parts), and

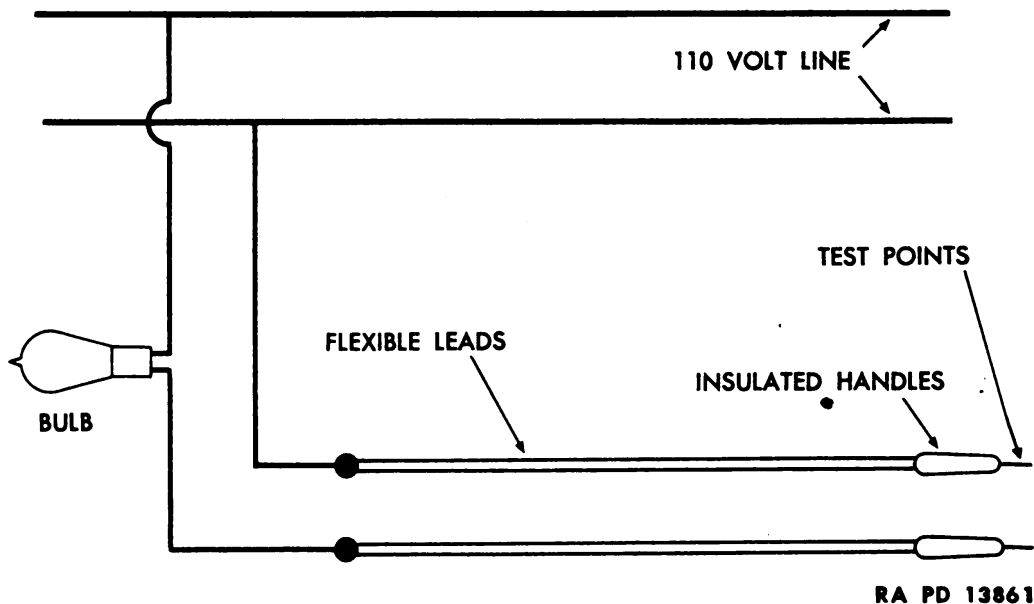


Figure 12—Test Points with Test Lamp

replacing brushes and brush springs as required. Correct a gummed or burned commutator (par. 11 a (1)). If the trouble is not readily apparent, use test lamp, test points, and check further (fig. 12). Test lamp and test points will detect short circuits, grounds, and open circuits. The test points are connected in series with the test lamp and a source of electricity (110-volt circuit, for example). When the test points are held together, the lamp lights. Thus a short circuit in an electrical circuit is indicated by lighting of the test lamp when the points are placed across the circuit. Likewise, an open circuit is indicated by failure of the lamp to light when the points are placed from one to the other end of the circuit.

(a) **Test for Grounded Generator.** Raise and insulate grounded brush from the commutator, and check with test points from the "A" terminal (or lead) to the frame. Where field circuit is grounded inside generator, disconnect ground lead before making test. If test lamp

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

lights, indicating ground, raise third brush from commutator and check the "A" terminal (or lead) and the "F" terminal (or lead) separately to determine whether the armature or field circuit is grounded.

(b) *Test for Open Field Circuit.* Check for open field circuit with test points from the "F" terminal (or lead) to the third brush holder. If lamp does not light, field is open. Leads which have broken or

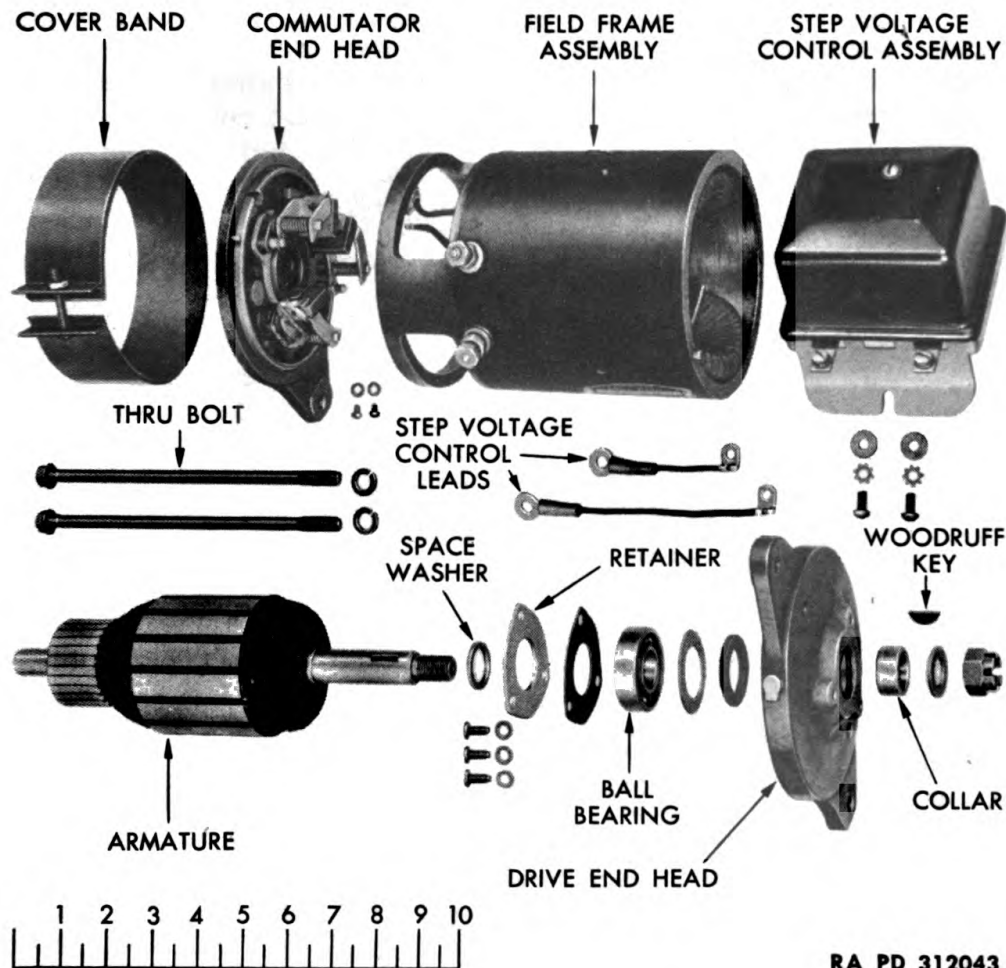


Figure 13—Type One Generator Disassembled

connections which have come loose to produce this condition may be resoldered, using resin flux. If open circuit is inside a field winding, replace field winding.

(c) *Test for Shorted Field.* Connect a battery and an ammeter in series with the field circuit to determine field current draw (par. 14). Proceed with care on this test, since a shorted field will draw a high current which might damage the ammeter or other equipment. If a shorted field is found, replace the field.

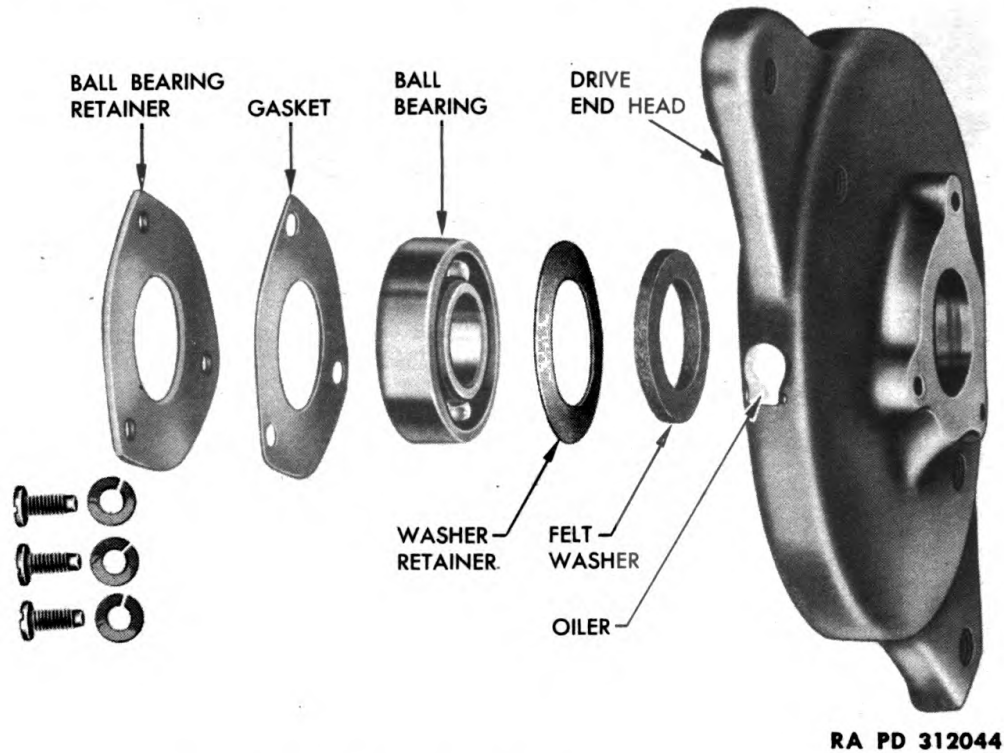
(d) *Open Circuited Armature.* An open circuited armature is

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usually readily apparent, since this condition causes burned commutator bars (pars. 10 b (2) and 11 a (2)).

(e) *Test Armature for Short Circuits.* Check the armature on a growler for short circuits (par. 10 b (3)).

(2) **EXCESSIVE GENERATOR OUTPUT.** Excessive generator output may result from a grounded generator field coil, or from an excessively advanced third-brush setting. Under some conditions, even a "normal" third-brush setting and a properly operating step-voltage control or voltage regulator (where used) will still cause excessive generator output and battery overcharge. When battery overcharge is experienced (as shown by excessive use of water) checks show the generator third brush is not too far advanced, and the control or



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Figure 14—Drive End Head, Disassembled

regulator is operating correctly, then the third-brush setting should be somewhat further retarded. Care must be used in making this re-adjustment, since an excessively low generator output will cause a run-down battery. The generator output must be such as to just balance the load requirements, and keep the battery in a charged condition, without excessive overcharging. The field may be checked for ground (par. 8 c (1) (a)), and the third-brush setting checked (par. 13).

(3) **UNSTEADY OR LOW GENERATOR OUTPUT.** Unsteady or low generator output may result from several conditions, as follows:

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

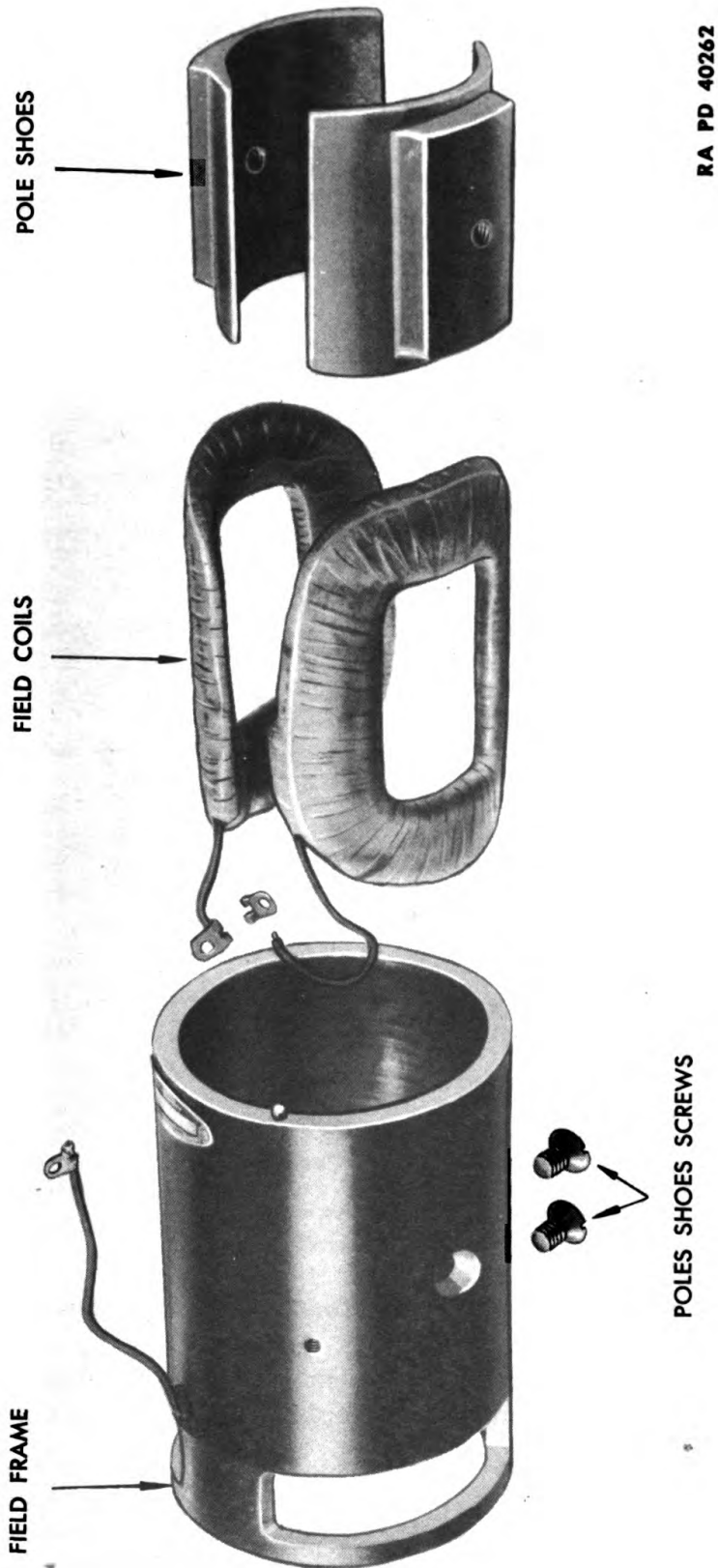
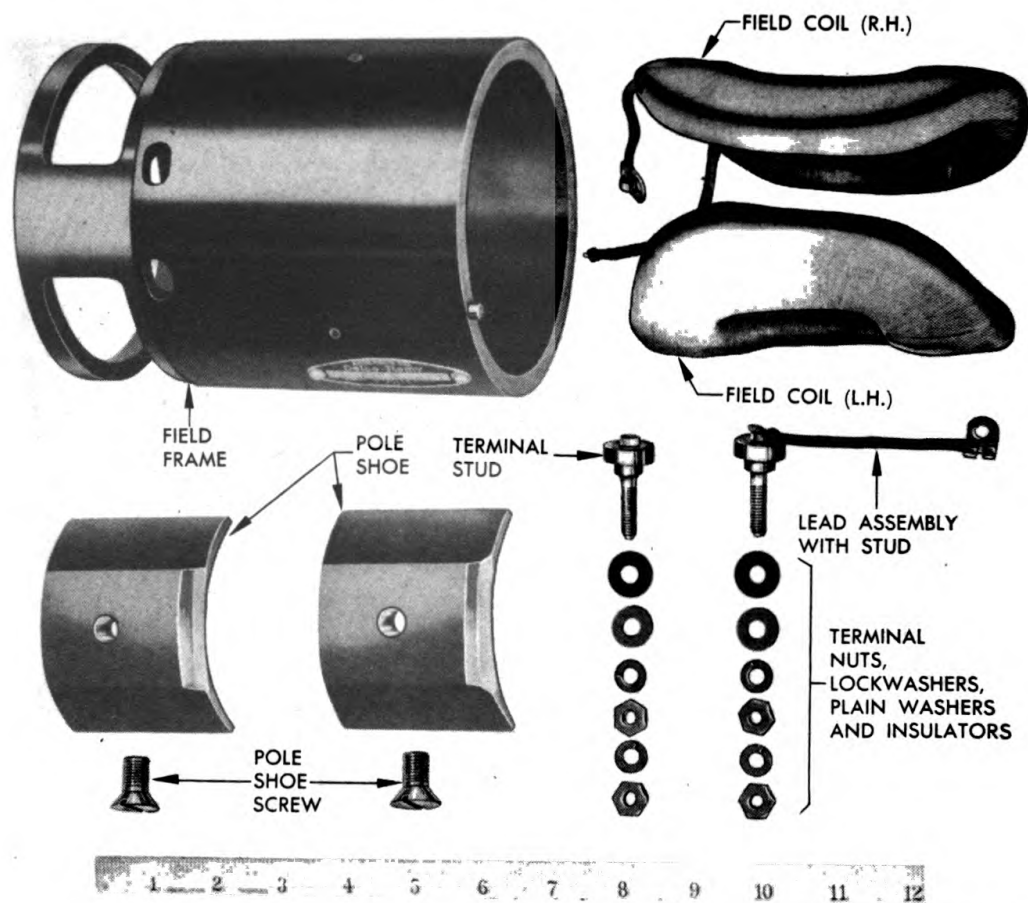


Figure 15—Field Frame with Insulating Bushings Disassembled

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- (a) Loose drive belt.
- (b) Sticking brushes, low brush spring tension, dirty commutator, or other conditions which prevent good contact between brushes and commutator.
- (c) Commutator which is rough, out-of-round, dirty, or burned. Dirt in the slots or high mica may also cause low or unsteady output.
- (4) **NOISY GENERATOR.** A noisy generator may be caused by loose mounting, drive pulley, worn or dirty bearings, improperly



RA PD 312045

Figure 16—Field Frame with Terminal Studs Disassembled

seated brushes, or bent brush holder. Tighten mounting, pulley, replace bearings, seat brushes, or replace brush holders as required.

9. DISASSEMBLY.

a. Disassembly Into Main Subassemblies (fig. 13).

- (1) Detach relay or step-voltage control (where present) by disconnecting leads and removing attaching screws and washers.

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

(2) Remove cover band by snapping back catch or loosening screw according to attaching arrangement.

(3) Disconnect insulated brush and third brush leads by removing screws and washers.

(4) Detach commutator end head assembly by removing two through bolts and washers. Loosen end head with a soft hammer if necessary.

(5) Detach field frame, using soft hammer to loosen if necessary.

(6) Separate armature and drive end head. Place armature in soft jaws of a vise, and remove pulley or gear nut (where present). Pull

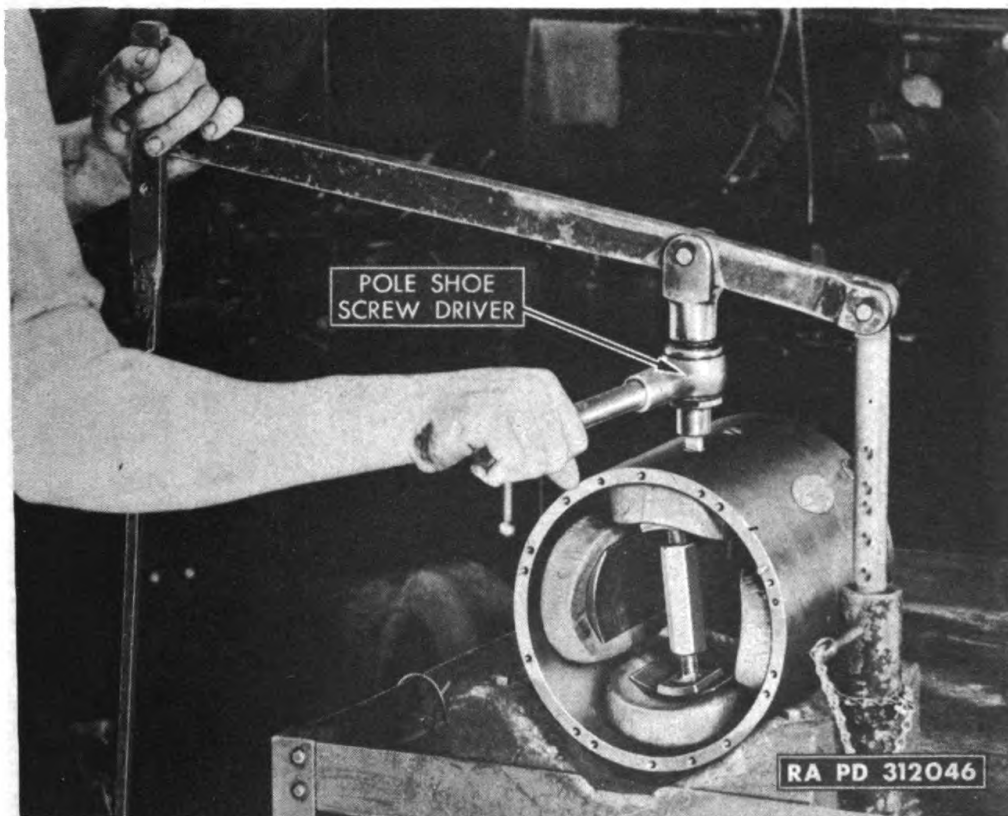


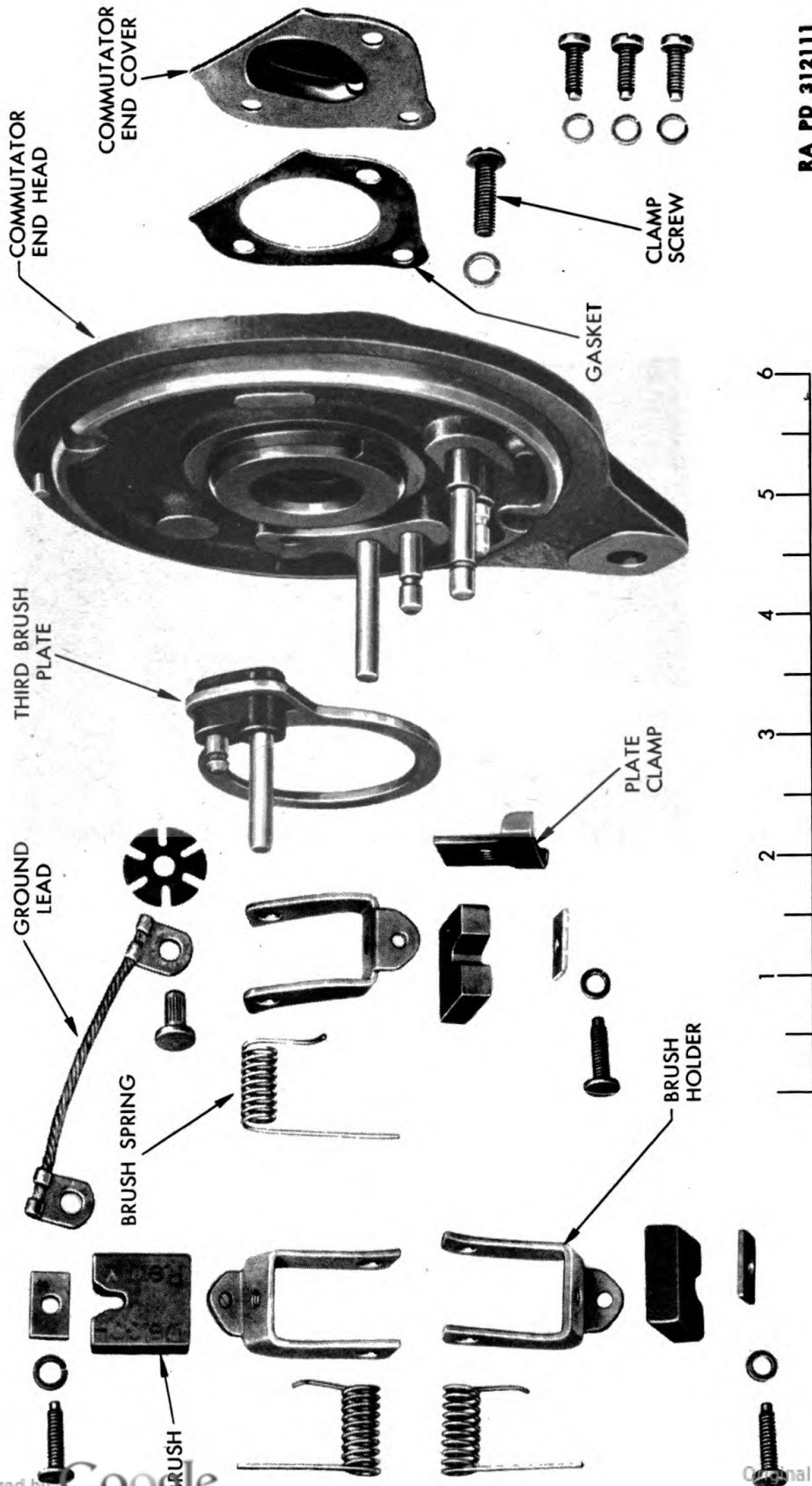
Figure 17—Using Pole Shoe Screwdriver to Remove Pole Shoe Screws

pulley or gear with a puller, then slip off drive end head. It may be necessary to press the armature out of drive end head in an arbor press. Remove collar from outside of head, and washer from armature shaft.

b. Disassembly of Drive End Head (fig. 14).

(1) Detach bearing retainer by removing screws and washers. Remove gasket and ball bearing. Press out bearing if necessary with arbor press. Support inner race where possible.

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Figure 18—Commutator End Head with Plain Bearing and Swivel-type Brush Holders, Disassembled

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

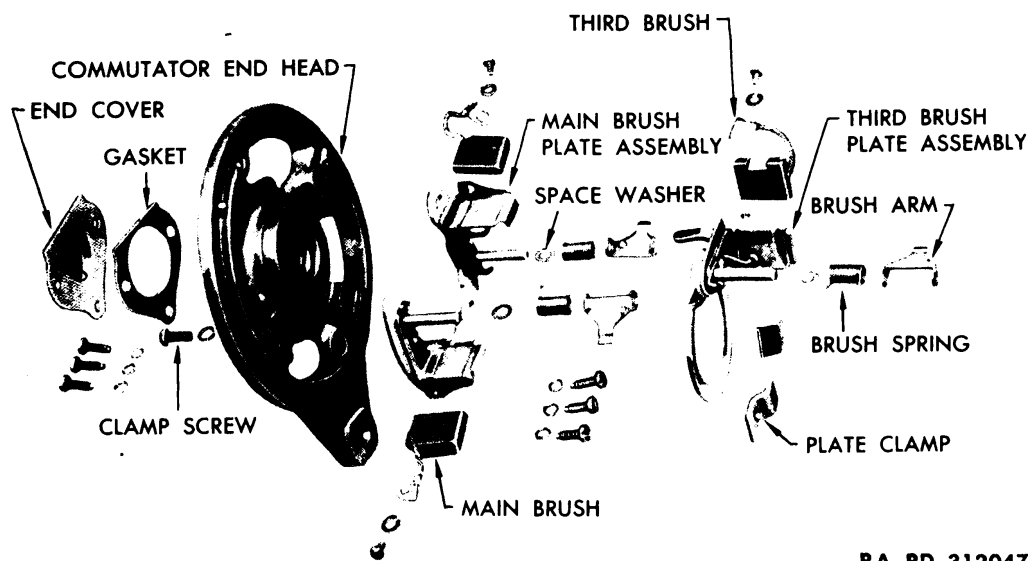
(2) Inner retainer and felt washer may be pressed out of end head if necessary. *NOTE: Some generators use a sealed type ball bearing which does not require gaskets or felt retainers.*

c. Disassembly of Field Frame. Some field frames have terminal studs held in place by washers and nuts (figs. 11 and 16), while others use insulating bushings through which leads pass (figs. 9 and 15).

(1) Detach terminal studs (where present) by removing nuts, washers, and insulators. "F" terminal stud has field coil lead soldered to it (fig. 16).

(2) Where leads pass through bushings in field frame, unsolder clips to pull leads through frame (fig. 15).

(3) Remove field coils by taking out pole shoe screws with pole shoe screwdriver (fig. 17). Some pole shoes have one screw (fig. 8), while others have two (fig. 11). *NOTE: Some field coils are varnished*



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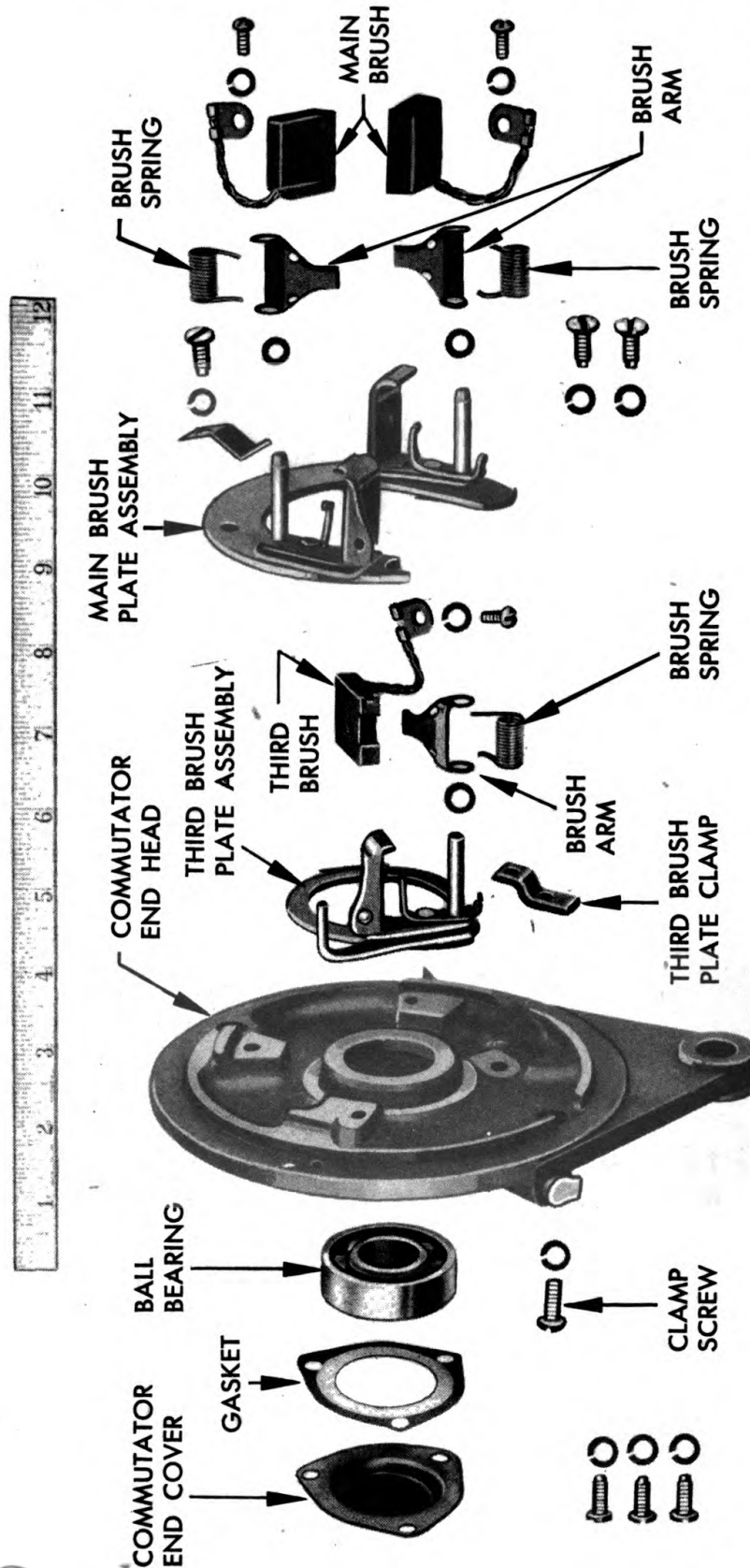
Figure 19—Commutator End Head with Plain Bearing and Reaction-type Brush Holders, Disassembled

and baked in place in the field frame and cannot be removed. If field coils are baked in place, they are not serviceable separately. Defective field coils require replacement of field and frame assembly.

d. Disassembly of Commutator End Head. Disassembled views of the three types of commutator end heads used in group one generators are shown in figures 18, 19 and 20.

(1) Disassemble type shown in figure 18 by detaching end cover and gasket, grounded brush lead attaching screw, brush arms and springs, and third brush plate. Remove brush arms, with springs,

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Figure 20—Commutator End Head with Ball Bearing and Reaction-type Brush Holders, Disassembled

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by lifting ends of springs over stop pins. Detach third brush plate by pushing plate spring attaching pin out with $\frac{1}{8}$ -inch punch and then loosening third brush clamp by backing out screw. If bearing requires replacement, press out in arbor press.

(2) Disassemble type shown in figure 19 by detaching end cover and gasket, grounded brush lead attaching screw, brushes, brush springs and arms, main and third brush plates. Raise brush arms to lift brushes from holders, lift ends of springs over spring stops and slip brush arms, springs and washers off pins. Detach main and

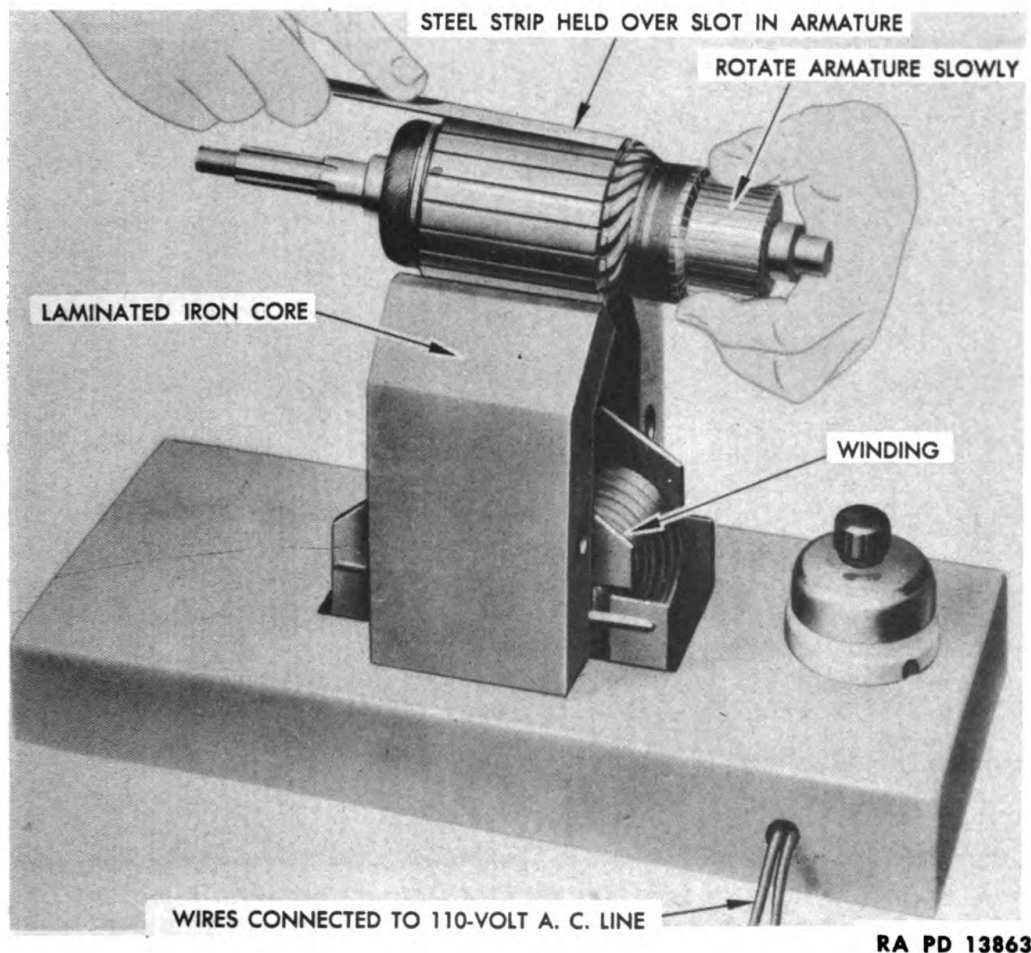


Figure 21—Testing Armature on Growler (17-G-5940)

third brush plates by backing out attaching screws. Press out old bearing in arbor press if it requires replacement.

(3) Disassemble type shown in figure 20 by same process outlined for type shown in figure 19, except that ball bearing retainer and felt washer in end head may also be removed. *NOTE: Some generators use a sealed type ball bearing which does not require gaskets or felt retainers.*

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10. CLEANING, INSPECTION, AND TEST OF PARTS.

a. **General.** After disassembly, clean and examine all parts, and replace defective parts. The procedure of cleaning and inspecting parts is given in following subparagraphs.

b. **Armature.** Do not clean the armature by any degreasing method, since this would damage the insulation and ruin the armature. Wipe with a clean cloth slightly dampened with dry-cleaning solvent. If commutator is rough, out-of-round, worn, has high mica, filled slots, or is burned, it must be turned down in a lathe (fig. 23),

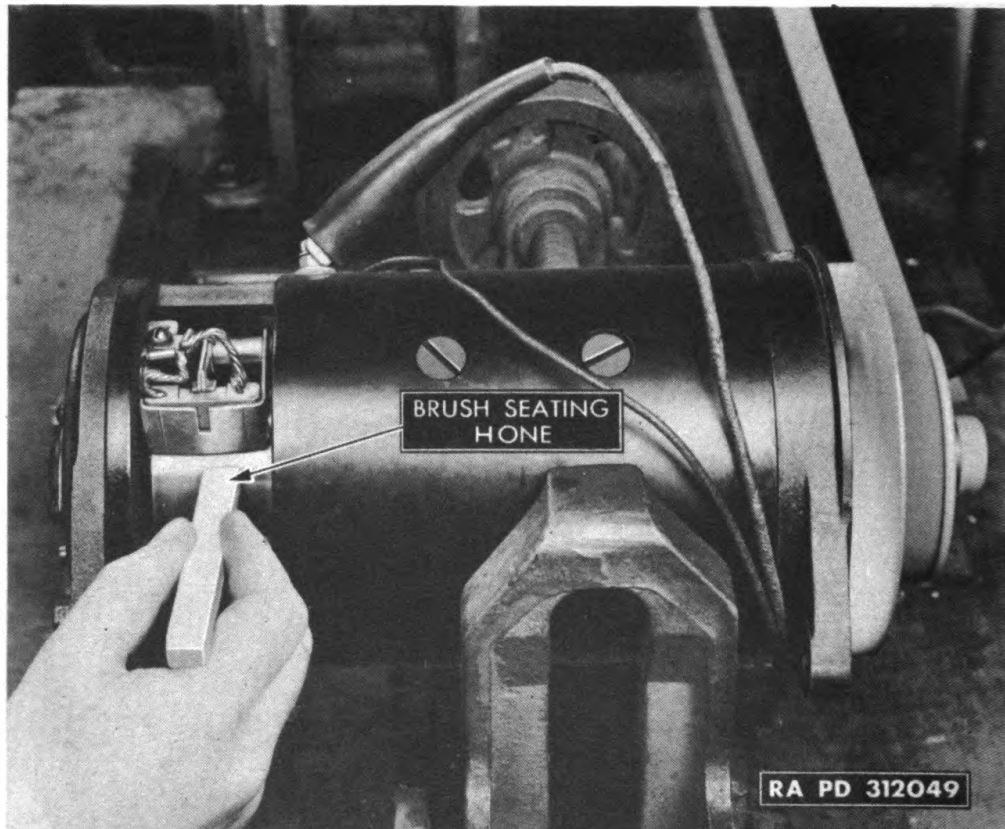


Figure 22—Using Brush Seating Hone (41-H-2387) to Seat Brushes

and the mica undercut (fig. 24), (par. 11 a (1)). Check armature for ground, open or short circuit as follows:

(1) **GROUND.** Check with test lamp and test points from the commutator to the armature shaft or lamination. If test lamp lights, indicating ground, and if the ground is not readily apparent and repairable, the armature must be replaced.

(2) **OPEN.** An open-circuited armature is easily detectable, since this condition produces badly burned commutator bars. The bars connected to the open coils in the armature soon burn, since every

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

time they pass under the brushes they interrupt a flow of current so that heavy arcing occurs. If the bars are not too badly burned, the armature may often be saved (par. 11 a (2)).

(3) **SHORT.** A shorted armature may be detected on a growler (17-G-5940) (fig. 21). The growler is a strong electromagnet connected to a source of alternating current. When a shorted armature is placed on the growler, and a hacksaw blade held above the shorted coils in the armature, the blade will be alternately attracted to and repelled from the armature. This causes the blade to buzz against the armature. Before discarding an armature testing shorted, inspect the commutator slots carefully, since copper or brush dust sometimes collects in the slots and shorts adjacent bars.

c. Fields. Do not clean fields by any degreasing method, since this would damage the insulation and ruin the coils. Clean by wiping with a clean, dry cloth. Be careful in handling the coil assembly to avoid breaking or weakening the connecting lead between the two coils. Test the field current draw by connecting battery and an ammeter in series with the two field leads. The current draw is given in the specifications table (par. 14). Replace coils if they do not meet specifications. The field insulation must be in good condition. If it is charred or worn away so that the wire is exposed, it is sometimes possible to rewrap the coils. All soldered connections must be made with the use of rosin flux. If the terminal stud or clip is damaged, replace it.

d. Brushes. If the brushes are worn down to less than half their original length, they must be replaced. Make sure that the pigtail leads (where present) are firmly in place in the brushes and that the clips are properly soldered to the leads. Seat new brushes with a brush seating hone (41-H-2387) (fig. 22). The brush seating stone is an abrasive material which, held against a revolving commutator, disintegrates, carries under the brushes, and seats them within one to two seconds.

e. Brush Springs. The brush springs must have sufficient tension to provide the proper pressure between the brushes and commutator after the unit is assembled. Check this during reassembly after assembling the brushes, brush springs, and arms to the commutator end frame. Place the commutator in position in the end frame, and then check with a spring gage the amount of pull required to raise the brush arms from the brushes. Replace springs if tension is not correct. (See specification table, par. 14.)

f. Bearings. Replace plain bearings if worn. If ball bearings appear to roll roughly, or sloppily, replace them. Otherwise, clean the ball bearings (if not of the sealed type) by rotating them in dry-cleaning solvent, drying them with air, and immediately relubricating with ball bearing grease. Never attempt to clean sealed ball bearings, but replace them if they appear defective. After new plain bearing is installed, it must have oil lead drilled in side for oil wick, and must then be machined to size. Remove all cuttings from oil well, and install new wick.

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g. Brush Rings. If the brush rings, brush arm pins, brush holders, or spring stop pins are damaged (bent, warped, cracked, insulation burned, etc.), replace brush ring. The rings are of riveted construction, so that they must be serviced as units.

h. Miscellaneous. Replace any defective insulator, screw, washer, lead, stud, retainer, plate, etc. Cracked, bent, battered, worn, burned insulators and washers are defective. Screws or studs that are bent, battered, broken, or that have crossed or damaged threads, are defective. Leads that have broken strands or badly frayed insulation, are defective.

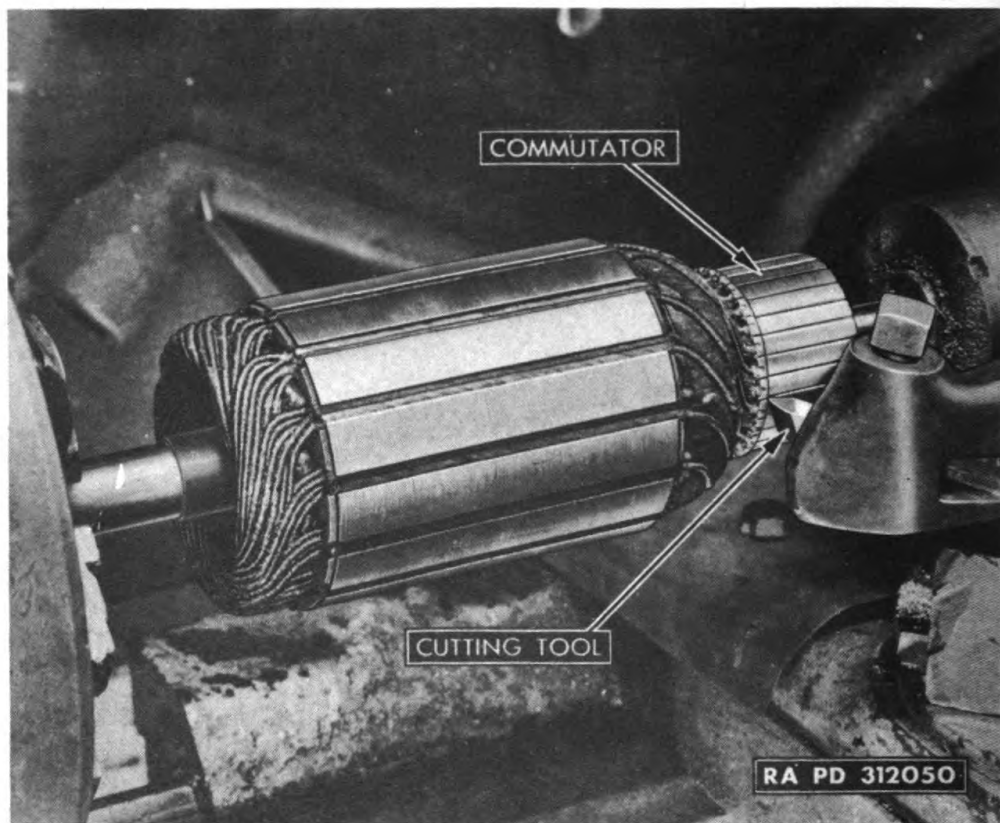


Figure 23—Turning Commutator in Lathe

11. REPAIR OF PARTS.

a. Armature. Conditions in the armature requiring repair are:

(1) **COMMUTATOR WORN, DIRTY, ROUGH, ETC.** If the commutator is worn, out-of-round, has high mica, filled slots, burned spots, or is rough, place the armature in a lathe and turn down the commutator (fig. 23). Make cut no deeper than necessary. If it is necessary to turn the commutator down so much that the ends of the commutator segments are less than $\frac{1}{16}$ inch thick, discard the armature. When the ends of the segments are less than $\frac{1}{16}$ inch thick, the commutator bars are so thin that they will not have sufficient

GROUP I—THIRD-BRUSH, TYPE ONE GENERATORS

strength to retain their shape at high speed. Undercut mica $\frac{1}{32}$ inch, using undercutter (41-U-300) and armature turning kit (41-A-75) (fig. 24).

(2) **ARMATURE OPEN.** Some bars badly burned, with other bars fairly clean, indicates an open-circuited armature. The open circuit will usually be found at the commutator riser bars and is often a result of generator overload. Excessively high generator output resulting from a too advanced third brush adjustment will cause generator overload. If the bars are not too badly burned the armature may sometimes be saved by resoldering the leads in the riser bars, using rosin flux, turning the commutator down, and undercutting

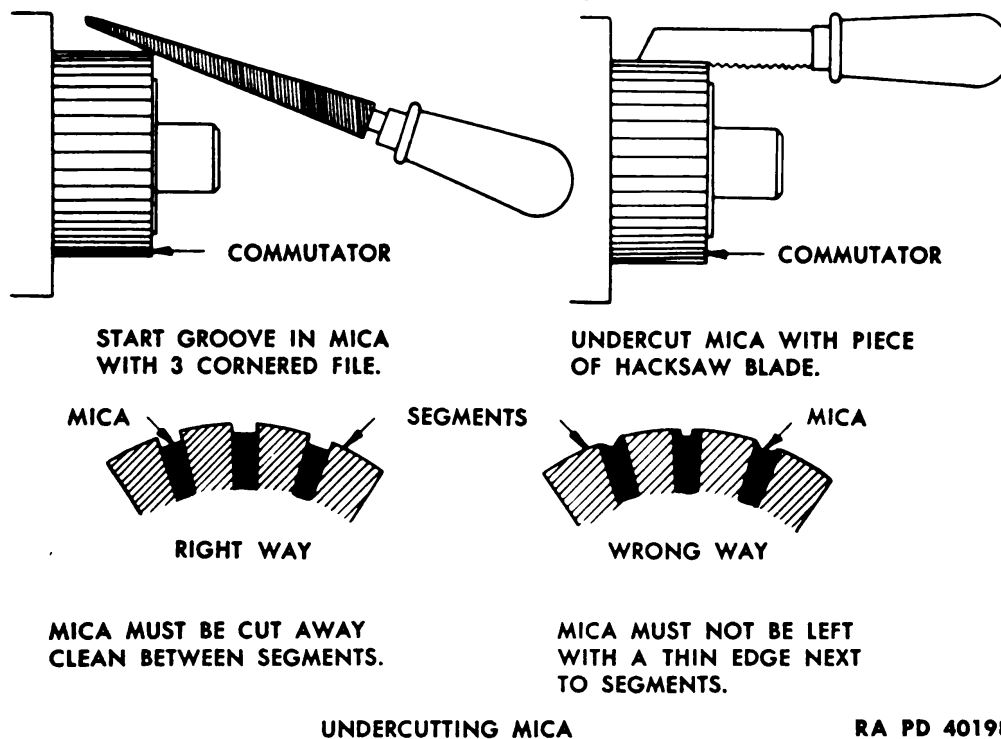


Figure 24—Undercutting Mica with Hacksaw Blade

the mica. Make sure the third brush is adjusted according to specifications.

b. Fields. Conditions in the field coils requiring repair are:

(1) **FIELD INSULATION DEFECTIVE.** If the field insulation is charred or worn away so the field circuit is, or could become, grounded, it may sometimes be repaired by rewinding the field coils. This operation must be executed with care and neatness, since excessive bulkiness of the wrappings will prevent reassembling the coils under the pole shoes in the proper manner. Make all soldered connections with the use of rosin flux.

(2) **CONNECTIONS DEFECTIVE.** If connections between coils to clips or studs are defective, resolder, using rosin flux. **CAUTION: Never use acid flux on electrical connections.**

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12. ASSEMBLY OF GENERATOR.

a. Assembly of Commutator End Head. The three types of commutator end heads (figs. 18 through 20) require somewhat different assembling procedures.

(1) Assemble type shown in figure 18 as follows:

(a) Replace bearing (par. 10 f).

(b) Attach third brush plate by driving in the spring attaching pin with spring in place, and then tighten screw holding the clamp.

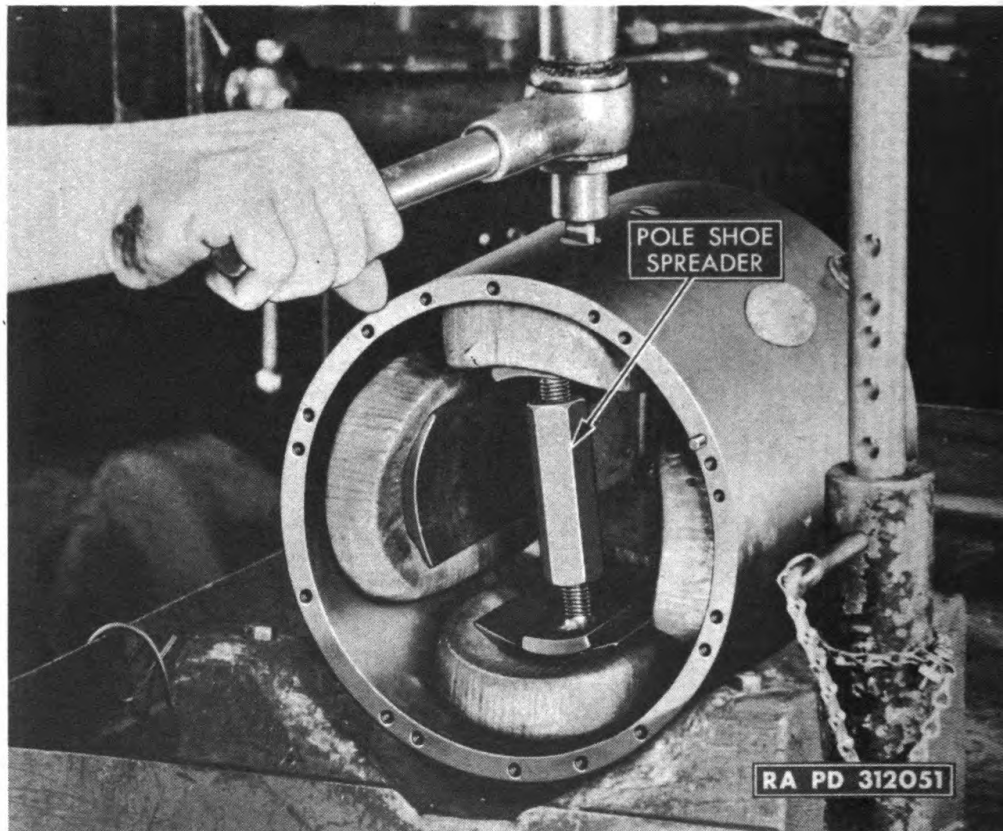


Figure 25—Using Pole Shoe Spreader

(c) Install brush arms with springs. Lift ends of springs up over stop pins.

(d) Connect grounded brush lead with screw and washer.

(e) Attach end cover and gasket with screws and washers.

(2) Assemble type shown in figure 19 as follows:

(a) Replace bearing (par. 10 f).

(b) Attach main and third brush plates with screws and washers.

(c) Install brush arms, washers, and springs. Lift ends of springs over stops.

(d) Attach grounded brush lead to holder.

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- (e) Install brushes after end head is attached to field frame.
- (f) Attach end cover and gasket.
- (3) Assembly of type shown in figure 20 is same as for type shown in figure 19 except that ball bearing retainer and felt washer (where used) are installed before ball bearing, end plate and gasket.

b. Assembly of Field Frame Varies Somewhat According to Type (figs. 9, 11, 15 and 16).

- (1) Attach field coils with pole shoes and screws, using pole shoe screwdriver (fig. 17) and holding shoes in position in a manner similar to that shown in figure 25.
- (2) On type with leads passing through bushings in field frame, push leads through and fasten and solder clips to ends (fig. 15).
- (3) On type with terminal studs, attach with insulators, washers, and nuts.

c. Assemble Drive End Head.

- (1) Install inner retainer and gasket (where used).
- (2) Install bearing and secure with gasket and retainer.

d. Assemble Generator From Component Subassemblies (fig. 13).

- (1) Place washer on armature shaft, press drive end head on in arbor press. Install collar, press pulley or gear on, and secure with washer and nut (also cotter pin if used).
- (2) Place field frame on assembly, alining dowel pin with holes, and then attach commutator end head with through bolts, alining dowel pins and holes.
- (3) Install brushes if not already in place, and connect insulated brush and third brush leads with screws and washers.
- (4) Put cover band in place.
- (5) Attach relay or step-voltage control and connect leads to terminals.

e. Install safety wire through holes in screws and twist ends together. Where safety wire is used inside the generator, on retainer plate screws or similar places, the safety wire must be installed before final assembly.

13. TESTS AND ADJUSTMENTS.

a. Mount generator on test stand, connect to test stand ammeter and voltmeter. Connect ammeter leads to generator "A" terminal and ground generator "F" terminal with a jumper lead if it is not connected to ground inside the generator. Operate generator at speed at which maximum output is obtained (par. 14). If output exceeds rated output with generator cold, immediately remove cover band, loosen third brush ring lock screw in commutator end head and move third brush away from main brush to reduce output to rated output.

b. Generator output at specified voltage must be checked. If specified voltage cannot be attained, insert $\frac{1}{4}$ ohm variable

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sistance of sufficient current-carrying capacity into the charging circuit and cut resistance in until the specified voltage is attained. Operate until generator reaches operating temperature (about 30 minutes). At operating temperature, the generator must produce rated hot output at rated voltage at rated revolutions per minute (read speed if an indicator is available). Adjust by moving the third brush toward the main brush to increase output, or move third brush away from main brush to lower output. After adjustment is complete, tighten the lock screw and replace cover band. **NOTE:** *Always check the generator output at the specified voltage. Never set the output beyond the specified value. Failure to observe these rules causes a high setting which will damage the generator.*

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14. TEST DATA AND TOLERANCES.

a. Test Data.

TEST SPECIFICATIONS FOR GROUP I GENERATORS

DR Part No.	Retention	Brush Tension (oz)	Field Current at 6 Volts (Amps)	COLD OUTPUT		HOT OUTPUT		Approx RPM
				Amps	Volts	Amps	Volts	
948-R	C	25	2.3-2.6	19-23	8.4-8.8	16-20	8.1-8.5	3100
960-C	C	16	2.3-2.6	19-23	8.4-8.8	16-20	8.1-8.5	3100
968-R	C	25	2.8-3.2	23-26	8.8-9.2	19-22	8.4-8.8	2000
1100452	C	25	2.3-2.6	17-20	8.2-8.5	13-15	7.7-8.0	3000
1100456	C	25	2.3-2.6	19-23	8.4-8.8	16-20	8.1-8.5	3100
1100459	C	25	2.3-2.6	18-21	8.2-8.5	15-18	7.9-8.3	2900
1101354	C	16	3.5-4.5	13-16	7.7-8.1	9-11	7.3-7.6	1900
1101374	C	16	3.5-4.5	11-13	7.5-7.8	9-11	7.3-7.6	2100
1101382	C	16	3.5-4.5	11-13	7.5-7.8	9-11	7.3-7.6	2100
1101662	C	17	4.0-6.1	19-22	8.3-8.7	9-12	7.3-7.7	1800-2000
1101675	CC	16	4.0-6.1	15-17	7.9-8.15	11-14	7.5-7.85	1700-1800
1101681	C	16	4.0-6.1	15-17	7.9-8.15	11-14	7.5-7.85	1700-1800
1101714	C	25	1.5-1.65*	18-21	15.0	15-18	15.0	3500
1101747	C	16	1.5-1.67*	8-10	14.4-14.9	6-8	14.1-14.5	2400
1101751	C	25	1.5-1.67*	8-10	14.4-14.9	6-8	14.1-14.5	2400
1102423	C	25	1.4-1.5	16-19	8.0-8.4	12-15	7.6-8.0	1800
1102527	C	16	2.5-3.0*	11-13	15.1-15.5	7-9.5	14.2-14.8	2000
1105377	C	25	1.35-1.55*	16-18	16.1-16.5	11-13	15.1-15.5	2600
1105380	C	25	1.35-1.55*	16-18	16.1-16.5	11-13	15.1-15.5	2600
1105381	C	25	1.35-1.55*	16-18	16.1-16.5	11-13	15.1-15.5	2600
1105753	C	25	0.63-0.69†	5-7	26.0	4.5-6.5	26.0	2000
1105755	CC	25	0.84-0.92†	6-8	34.0	—	—	—
1105764	C	16	0.63-0.69†	5-7	26.0	4.5-6.5	26.0	2000
1106257	C	25	1.53-1.67	26-28	7.0	21-23	7.0	1600

*Field Current at 12 volts
 †Field Current at 24 volts
 ‡Field Current at 32 volts

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b. Fits and Tolerances.

GROUP I GENERATORS—FITS AND TOLERANCES

Nomenclature:

C.E.—Commutator End
Comm Diam—Commutator Diameter
D.E.—Drive End
I.D.—Inside Diameter
O.D.—Outside Diameter

Model	Brush Length (inch)		Comm Diam (inch)	BEARINGS	
	Main Brush	Third Brush		C.E.	D.E.
948-R	13/16	23/32	1.800	a	c
960-C	13/16	23/32	1.800	a	c
968-R	13/16	23/32	1.800	a	c
1100452	13/16	23/32	1.800	a	c
1100456	13/16	23/32	1.800	a	c
1100459	13/16	23/32	1.800	a	c
1101354	3/4	47/64	1.800	a	c
1101374	3/4	3/4	1.800	a	c
1101382	3/4	47/64	1.800	a	c
1101662	3/4	3/4	1.800	a	d
1101675	3/4	3/4	1.800	b	c
1101681	3/4	3/4	1.800	c	d
1101714	13/16	23/32	1.800	a	c
1101747	3/4	3/4	1.800	a	c
1101751	13/16	23/32	1.800	a	c
1102423	13/16	23/32	1.800	a	c
1102527	3/4	3/4	1.800	c	d
1105377	13/16	23/32	2.187	c	d
1105380	13/16	23/32	2.187	c	d
1105381	13/16	23/32	2.187	c*	c
1105753	13/16	23/32	2.187	c	c
1105755	13/16	23/32	2.187	c	c
1105764	13/16	23/32	2.187	c	c
1106257	13/16	23/32	2.187	c	e

a—Plain Bearing I.D. 0.562–0.563, shaft 0.5605–0.5610.

b—Ball Bearing I.D.—0.4724, O.D. 1.2598, Shaft 0.4716–0.4722, End Head, 1.2600–1.2605.

c—Ball Bearing I.D. 0.6693, O.D. 1.5748, Shaft, 0.6684–0.6690, End Head 1.575–1.576.

d—Ball Bearing I.D. 0.7874, O.D. 1.8504, Shaft 0.7865–0.7871, End Head, 1.8508–1.8513.

e—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–0.9841, End Head 2.4411–2.4419.

*Shaft—.6691–.6696

CHAPTER 2
GENERATORS (Cont'd)

Section III

**GROUP II—TWO-BRUSH, TYPE ONE OR
TYPE TWO GENERATORS**

	Paragraph
Description	15
Cleaning, inspection, and test.....	16
Disassembly	17
Cleaning, inspection, and test of parts.....	18
Repair of parts	19
Assembly of generator	20
Tests and adjustments	21
Fits, tolerances, and data.....	22

15. DESCRIPTION.

a. The generators in this group are all two-brush, shunt units, either type one or type two (figs. 1 and 2). All use reaction type brush holders, have ball bearings in the drive end and operate with separately mounted current and voltage regulators. Some use plain, others ball bearings in the commutator end. Ball bearings may or may not be the sealed type. One type uses a terminal box to provide for radio interference shielding (fig. 27). Another has a bracket for mounting a radio interference filter to the field frame (fig. 26). Figures 26 through 33 illustrate variations of construction to be found in this group of generators.

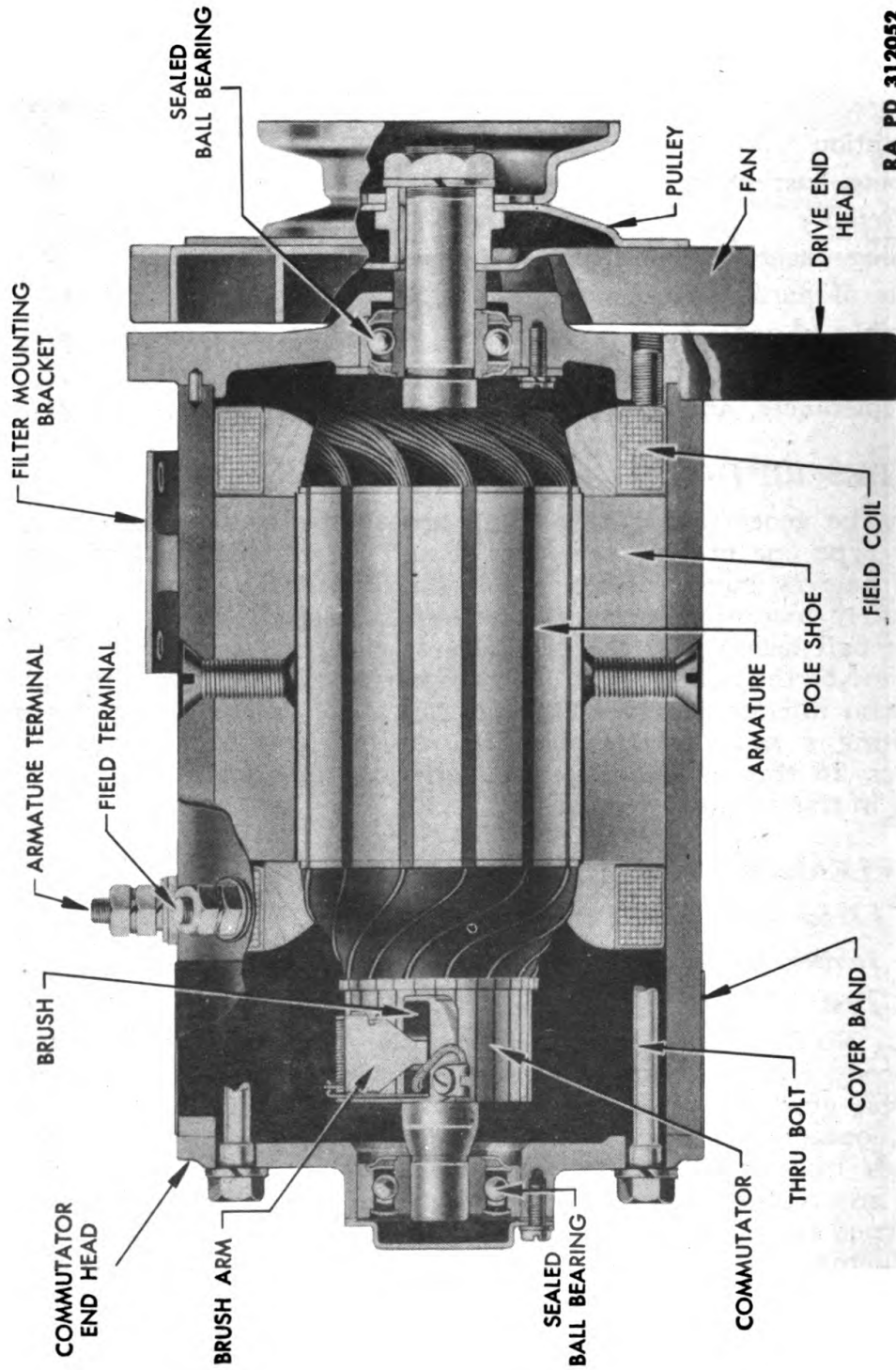
16. CLEANING, INSPECTION, AND TEST.

- a. **Clean Generator.** Refer to paragraph 8 a.
- b. **Inspect Generator.** Refer to paragraph 8 b.
- c. **Test.**

(1) **No OUTPUT.** If the generator is placed on test stand and does not produce any output, remove cover band and check for sticking brushes, gummed or burned commutator or for other causes of poor contact between commutator and brushes. Correct sticking brushes by cleaning brush holders and brush arms (replacing if bent) and replacing brushes and springs as required. Correct gummed or burned commutator (par. 11 a). If trouble is not readily apparent, test further as below. Testing procedure is different for type one and type two generators (figs. 1 and 2).

(a) *Type One.* (Uses regulator shown in figure 72.) Test for grounded generator by raising and insulating grounded brush from commutator and checking with test points from "A" terminal to frame. If test lamp lights, indicating ground, raise other brush and check field circuit ("F" terminal to frame) and commutator sepa

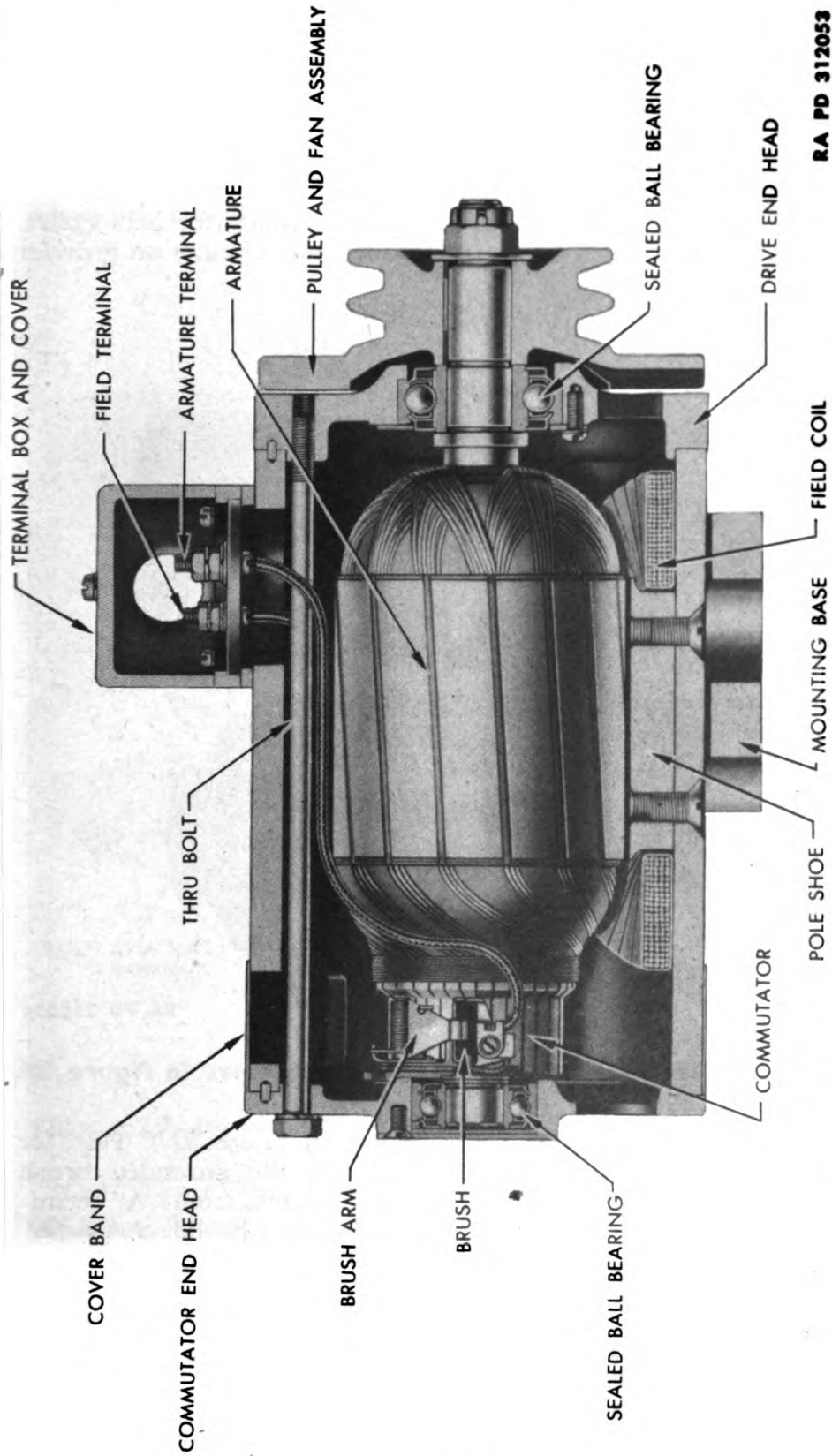
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RA PD 312052

Figure 26—Two-brush Shunt Generator with Sealed Ball Bearings and Reaction Brush Holders

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RA PD 312053

**Figure 27—Two-brush Shunt Generator with Sealed Ball Bearings,
Reaction Brush Holders, and Terminal Box**

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rately. Test for open field circuit with test points from "A" to "F" terminals. If lamp does not light, circuit is open. Test for shorted field circuit with battery and ammeter connected in series with field circuit. A shorted field will draw excessive current, so care must be taken to avoid damaging ammeter or other equipment. See specification table (par. 22) for normal current draw. If shorted field is found, replace it. An open circuited armature is usually readily apparent since this condition causes burned commutator bars (pars. 10 b (2) and 11 a (2)). Test armature for short circuits on growler (par. 10 b (3)).

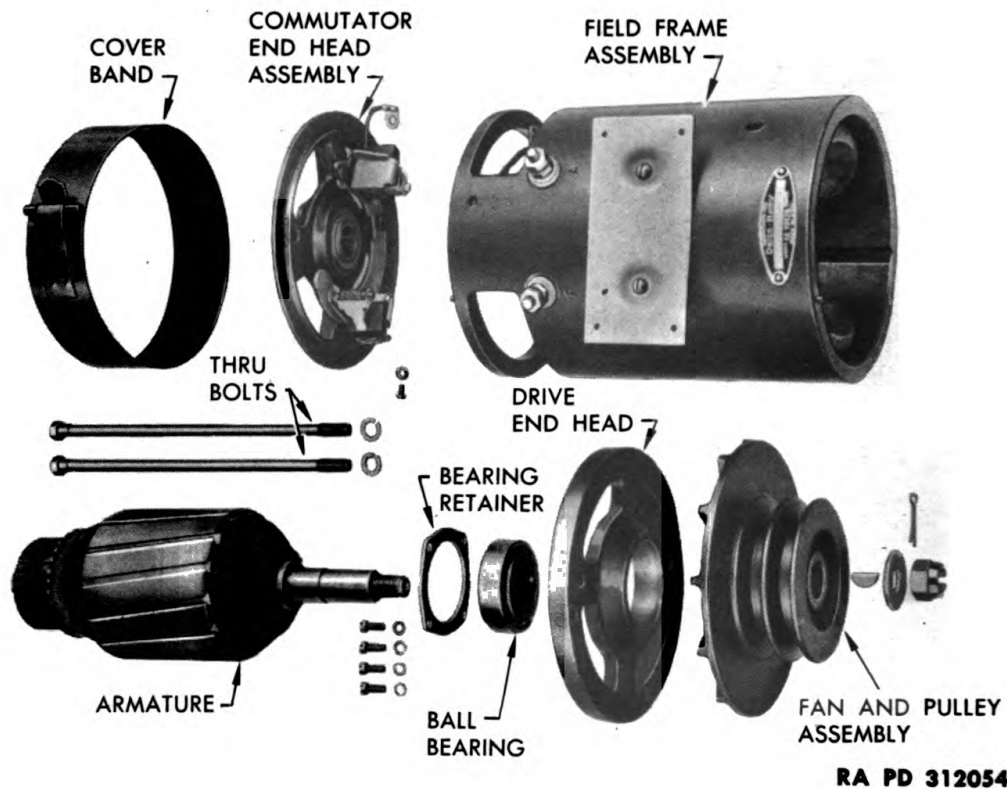


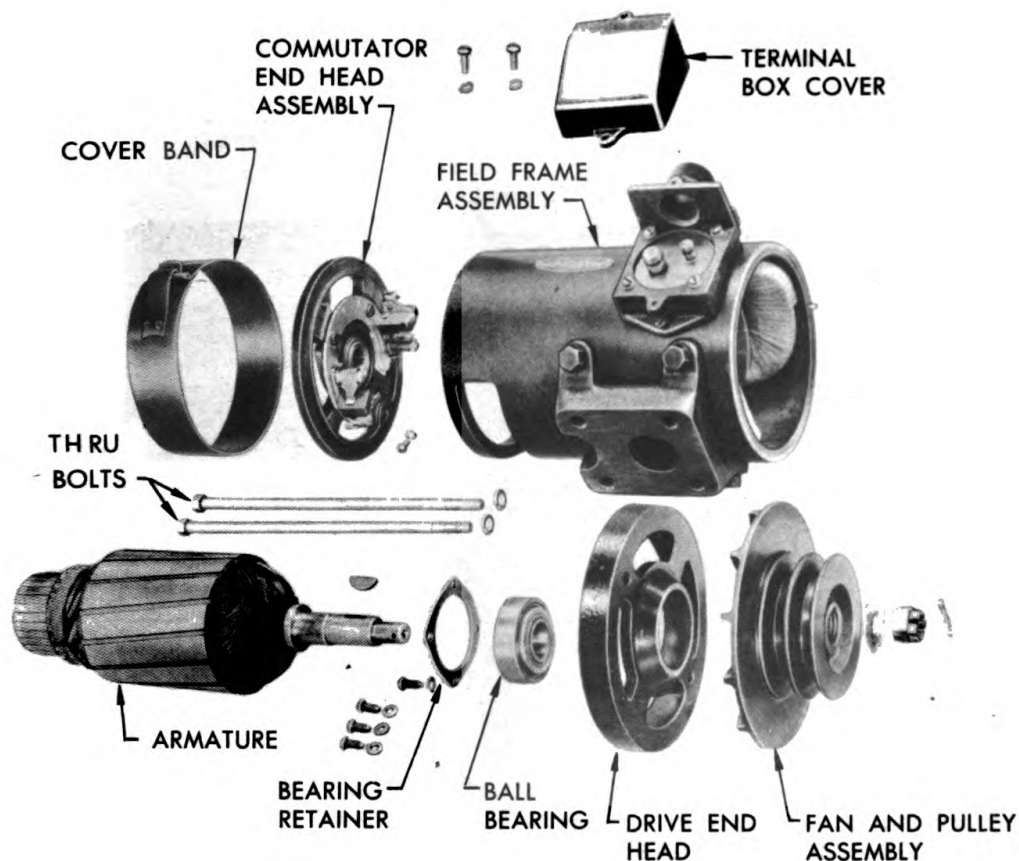
Figure 28—Disassembled View of Generator Shown in Figure 26

(b) *Type Two.* (Uses regulator shown in figure 82.) Test for grounded armature by raising and insulating the grounded brush from the commutator and checking with test points from "A" terminal to frame. If test lamp lights, raise other brush and check "A" terminal and commutator separately. Test for grounded field by disconnecting field lead from grounded brush or frame and checking from "F" terminal to frame. Check field circuit for open with test points from "F" terminal to field lead disconnected in previous test. Test for shorted field with battery and ammeter connected in series with field circuit. A shorted field will draw excessive current, so care must be used to avoid damage to ammeter and other equipment. See specification tables for normal current draw (par. 22). If shorted

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field is found, replace. An open circuited armature is usually readily apparent since this condition causes burned commutator bars (pars. 10 b (2) and 11 a (2)). Test armature for short circuits on growler (par. 10 b (3)).

(2) **EXCESSIVE GENERATOR OUTPUT.** All shunt generators will produce excessive output without regulation. If generator produces excessive output with proper regulator properly connected to the generator, check further according to generator type.



RA PD 312055

Figure 29—Disassembled View of Generator Shown in Figure 27

(a) *Type One.* This generator (fig. 1) will produce excessive output if the generator has an internally grounded field circuit that prevents regulator from inserting resistance into the generator field circuit in normal manner. Check by raising brushes from commutator and placing test points on frame and "F" terminal. If lamp lights, generator field circuit is grounded.

(b) *Type Two.* This generator (fig. 2) may produce excessive output due to an internal short that prevents regulator operation from inserting resistance into generator field circuit (rare). The

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short would have to be between the insulated brush and "F" terminal end of the field circuit to produce this result.

- (3) **UNSTEADY OR LOW OUTPUT.** Refer to paragraph 8 c (3).
- (4) **NOISY GENERATOR.** Refer to paragraph 8 c (4).

17. DISASSEMBLY.

a. **Disassembly Into Main Subassemblies** (figs. 28 and 29).

- (1) Remove cover band by snapping back catch or loosening screw according to attaching arrangement.
- (2) Disconnect leads from brush holders.

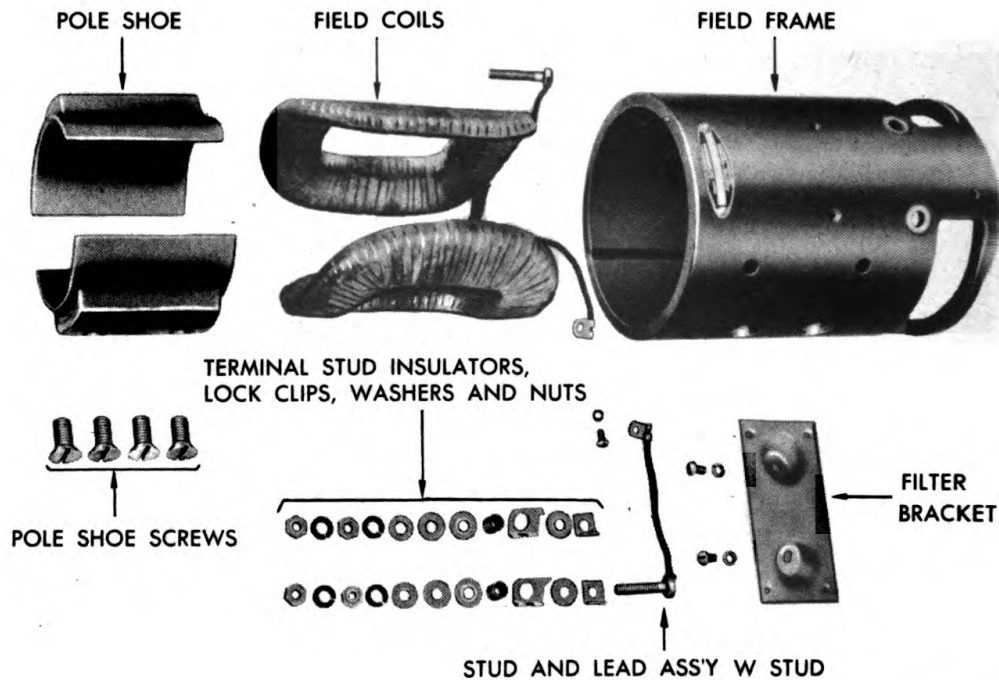
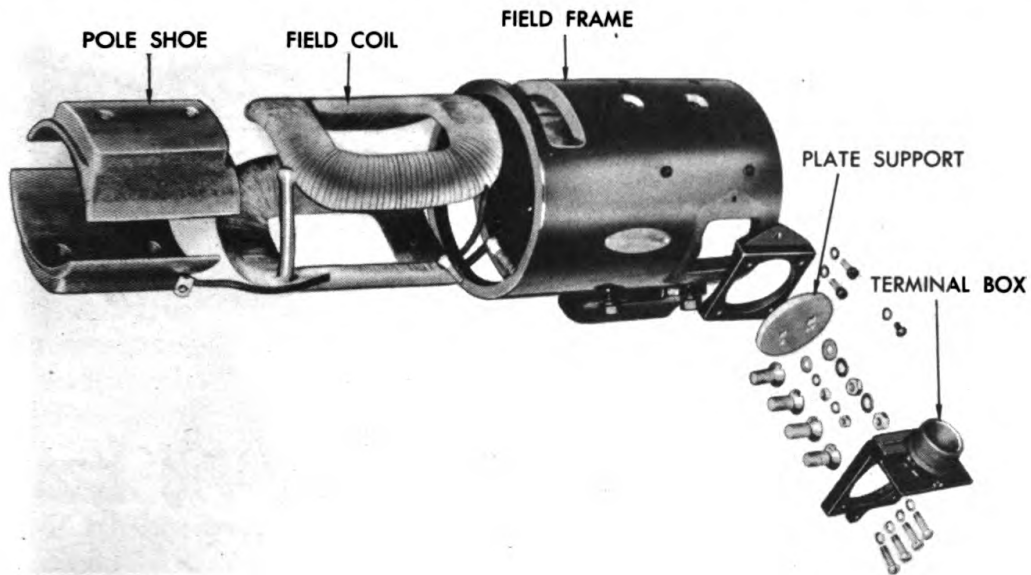


Figure 30—Field Frame, Disassembled

- (3) Detach commutator end head by removing two through bolts and washers. Tap with soft hammer to loosen, if necessary.
- (4) Detach field frame, using soft hammer if necessary to loosen.
- (5) Separate armature and drive end head by placing armature in soft jaws of vise and removing pulley or gear nut, pulling pulley or gear with puller, and slipping off drive end head. Use arbor press if end head does not come off easily.

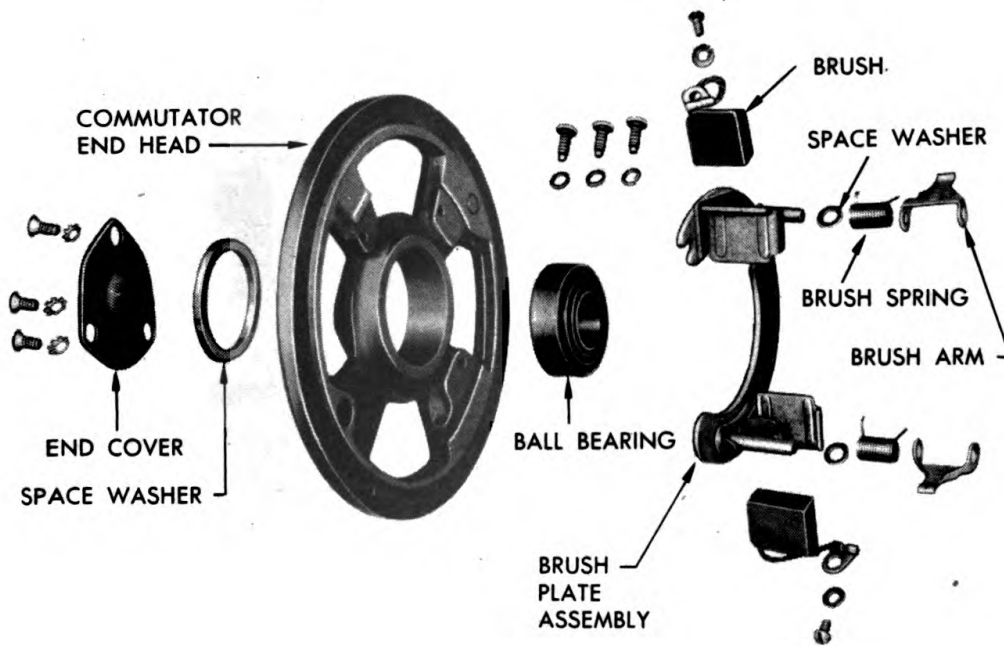
b. **Disassembly of Drive End Head.** Disassemble the drive end head with sealed ball bearing (figs. 28 and 29) by removing retainer and screws, and pressing out bearing. Support inner race where possible. Where bearing is not sealed (fig. 14), inner retainer and felt washer may also be removed.

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RA PD 40197

Figure 31—Field Frame with Terminal Box, Disassembled



RA PD 312057

Figure 32—Commutator End Head with Detachable Brush Plate, Disassembled

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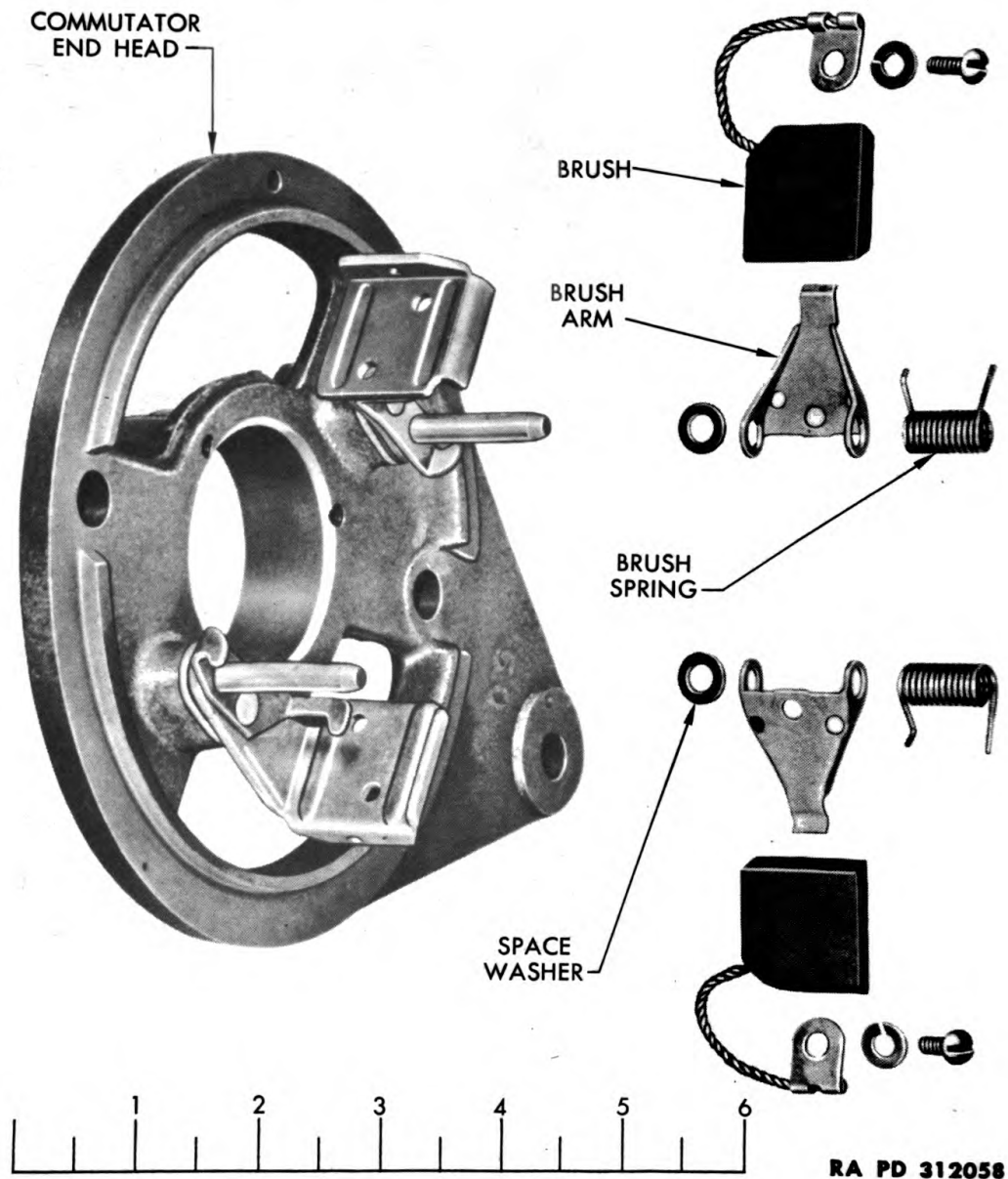


Figure 33—Commutator End Head with Riveted Construction, Disassembled

c. Disassembly of Field Frame (figs. 30 and 31).

(1) On frame with terminal box (fig. 31) disassemble box, noting relationship of box outlet and terminal studs with frame so they can be reassembled in same relationship.

(a) Detach cover (fig. 29) by removing two screws.

(b) Remove nuts and washers from "A" and "F" terminals, and push studs out of fiber mounting plate.

(c) Remove four screws and washers holding plate and support in place. If fiber plate requires replacement, press it out of support.

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(2) On other types, detach terminal studs from frame by removing nuts and washers.

(3) On all types, remove field coils by taking out pole shoe screws with pole shoe screwdriver (fig. 17). NOTE: *Some field coils are varnished and baked in place in the field frame and cannot be removed. If field coils are baked in place, they are not serviceable separately, and defective field coils require replacement of the field and frame assembly.*

d. Disassemble Commutator End Head. One type of commutator end head has a detachable brush ring (fig. 32), while another has the brush holders riveted to the end head (fig. 33). Ball bearing may or may not be of the sealed type.

(1) Where brush ring is detachable (fig. 32), remove screws to detach. On all types, remove brush arms and springs by lifting ends of springs over stops. Arms, springs, and washers, will then slide off pins.

(2) Remove bearing by detaching retainer and gasket. NOTE: *Bearing sometimes remains on armature shaft when commutator end head is removed. It may be left on shaft if not defective.*

18. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 10.

19. REPAIR OF PARTS.

a. Refer to paragraph 11.

20. ASSEMBLY OF GENERATOR.

a. **Assemble Commutator End Head** (figs. 32 and 33).

(1) Install bearing, attach brush ring (where detached), and install brush arms, springs, and washers. Lift ends of springs over stops. Install retainer and gasket (where used).

b. **Assemble Field Frame** (figs. 30 and 31).

(1) Install field coils and pole shoes with pole shoe screws, using pole shoe screwdriver (fig. 17) and pole shoe spreader (fig. 25).

(2) On type with terminal studs (fig. 30), install terminal studs and secure with insulators, washers, and nuts.

(3) On type with terminal box (fig. 31), attach terminal box fiber plate and support to base with four screws and washers. Relationship of terminals to the shield fitting (fig. 34) varies on some units. NOTE: *Relationship before disassembly must be noted so terminals can be located correctly on reassembly. Shield fitting must point away from mounting base.*

c. **Assemble Drive End Head** (figs. 28 and 29). Install bearing and retainer with felt washer (where used).

d. **Assemble Generator** (figs. 28 and 29).

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- (1) Press the drive end head on the armature shaft, first slipping washer on shaft (if used).
- (2) Press on pulley (first slipping on collar if used), and secure with washer and nut. If cotter pin is used, install it through nut and armature shaft hole. Hold armature in soft jaws of vise while tightening nut.
- (3) Aline holes and dowel, and put field frame in place.
- (4) Install commutator end head, alining dowel and holes. Secure assembly with bolts and washers.

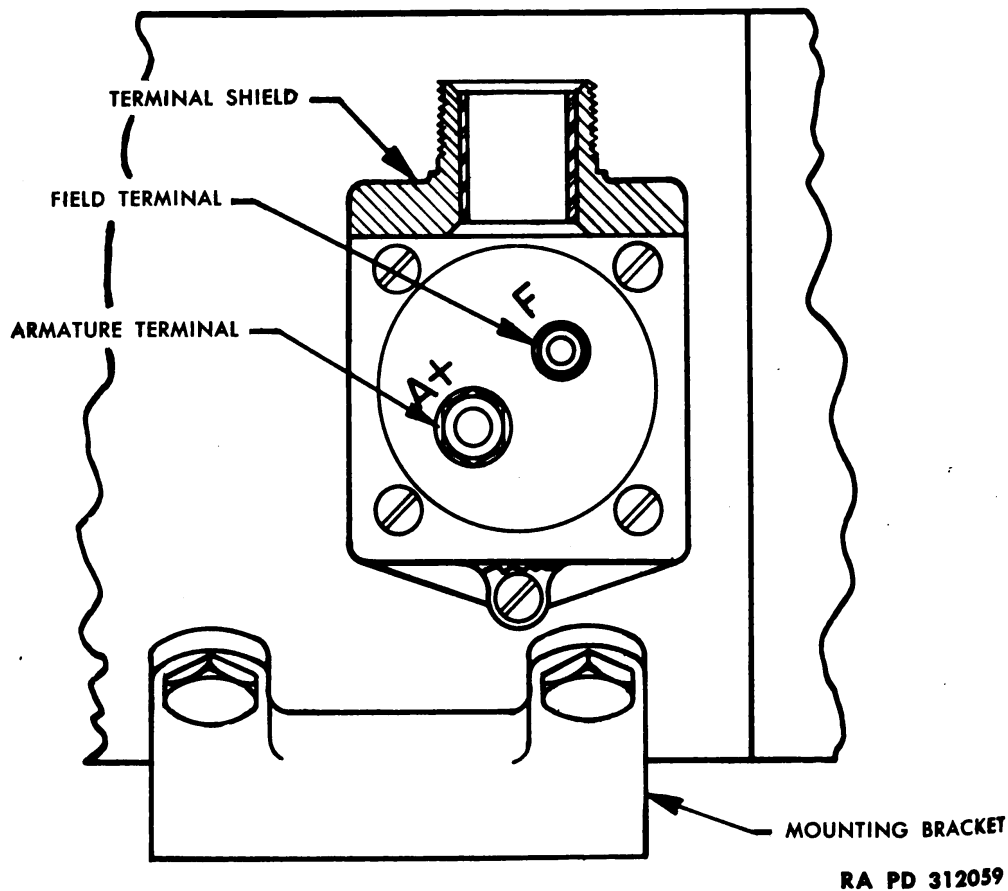


Figure 34—Terminal Arrangement in Terminal Box

- (5) Connect leads to brush holders.
- (6) Attach cover band.

e. Installing Safety Wire. Install safety wire through holes in screws (where present), and twist ends together. Where safety wire is used inside generator, on retainer plate screws, or terminal box mounting screws, the safety wire must be installed before final assembly.

GROUP II—TWO-BRUSH, TYPE ONE OR TYPE TWO GENERATORS

21. TESTS AND ADJUSTMENTS.

a. Mount generator on test stand, connect to test stand ammeter and voltmeter. Connect ammeter lead to generator "A" terminal and ground generator "F" terminal with a jumper lead if generator is type one (fig. 1). If generator is type two (fig. 2), connect jumper lead between "A" and "F" terminals. Increase speed and see if output can increase to rated maximum (par. 22). *NOTE: A shunt generator operated without regulation will produce excessive output at intermediate and high speed. Failure to operate correctly necessitates further checking as outlined in paragraph 16 c.*

22. FITS, TOLERANCES, AND DATA.

a. Test Data.

TEST SPECIFICATIONS FOR GROUP II GENERATORS

Model No.	Rotation	Brush Tension (oz)	Field Current at 6 Volts	COLD OUTPUT† Amps	Volts	Approx RPM
916-G	C	25	1.25-1.45*	17	14.5-14.75	1250
934-D	CC	25	1.25-1.45*	17	14.5-14.75	1250
934-F	C	25	1.7-2.0	26	8.1-8.3	1325
934-T	C	25	1.25-1.45*	17	14.5-14.75	1250
1102667	C	25	1.67-1.82	30	8.0	1750
1102670	C	25	1.67-1.82	30	8.0	1750
1102673	C	25	1.67-1.82	30	8.0	1750
1102674	C	25	1.67-1.82	30	8.0	1750
1102678	C	25	1.67-1.82	30	8.0	1750
1102690	C	25	1.67-1.82	30	8.0	1750
1102691	C	25	1.67-1.82	30	8.0	1750
1102953	C	25	1.6-1.7*	18	15.0	1480
1102955	C	25	1.6-1.7*	18	15.0	1480
1102956	CC	25	1.6-1.7*	18	15.0	1480
1102957	CC	25	1.6-1.7*	18	15.0	1480
1105202	C	25	1.1-2.0*	11	15.0	1175●
1105529	C	25	1.7-2.0	28	8.0	1400
1105530	C	25	1.7-2.0	28	8.0	1400
1105734	C	25	1.25-1.45*	17	14.5-14.75	1250
1105778	CC	25	1.25-1.45*	17	14.5-14.75	1250
1105780	C	25	1.25-1.45*	17	14.5-14.75	1250
1105854	C	25	1.7-1.9	25	8.0	1150
1105859	C	25	1.7-1.9	25	8.0	1150
1105860	C	25	1.82-1.94	40	8.0	1850
1105861	C	25	1.82-1.94	40	8.0	1850
1105862	C	25	1.70-1.90	25	8.0	1150
1105863	C	25	1.82-1.94	40	8.0	1850
1105864	C	25	1.82-1.94	40	8.0	1850
1105866	C	25	1.70-1.90	25	8.0	1150
1105867	C	25	1.82-1.94	40	8.0	1850
1105868	C	25	1.70-1.90	25	8.0	1150

*Field current at 12 volts.

●Hot output 11 amps 15.0 volts 1550 rpm.

†Output at given speed—not necessarily maximum output. Maximum output controlled by current regulator.

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TEST SPECIFICATIONS (Cont'd)**

Model No.	Rotation	Brush Tension (oz)	Field Current at 6 Volts	COLD OUTPUT‡		Approx RPM
				Amps	Volts	
1105902	C	25	1.1-1.2*	26	15.0	1500
1105903	C	25	1.1-1.2*	26	15.0	1500
1105906	C	25	1.1-1.2*	26	15.0	1500
1106403	C	25	1.77-2.0	35	8.0	1040
1106408	C	25	1.77-2.0	35	8.0	1040
1106453	C	25	1.2-1.26*	16	15.0	1050
1106454	CC	25	1.2-1.26*	16	15.0	1050
1106457	C	25	1.2-1.27*	50	13.0	2500
1106458	C	25	1.40-1.48*	50	13.0	2750
1106459	C	25	1.40-1.48*	50	13.0	2750
1106501	C	25	0.78-0.84 [^]	10	32.5	1080
1106502	C	25	0.58-0.63 [†]	10	26.0	1200
1106503	CC	25	0.58-0.63 [†]	10	26.0	1200
1106504	C	25	0.58-0.63 [†]	10	26.0	1200
1106505	CC	25	0.58-0.63 [†]	10	26.0	1200
1106506	C	25	0.58-0.63 [†]	10	26.0	1200
1106507	CC	25	0.58-0.63 [†]	10	26.0	1200
1106539	C	25	0.8-0.89 [†]	12	26.0	1200
1106540	C	25	0.59-0.63 [†]	15	26.0	1390
1106541	CC	25	0.49-0.53 [^]	10	35.0	1175-1225
1106542	C	25	0.49-0.53 [^]	10	35.0	1175-1225
1106543	C	25	0.59-0.63	12	26.0	1200
1106544	C	25	0.78-0.84	10	35.0	1000

*Field current at 12 volts

†Field current at 24 volts

[^]Field current at 32 volts

‡Output at given speed—not necessarily maximum output. Maximum output controlled by current regulator.

GROUP II—TWO-BRUSH, TYPE ONE OR TYPE TWO GENERATORS

b. Fits and Tolerances.

GROUP II GENERATORS—FITS AND TOLERANCES

Nomenclature:

- C.E.—Commutator End
- Comm Diam—Commutator Diameter
- D.E.—Drive End
- I.D.—Inside Diameter
- O.D.—Outside Diameter

Model	Brush Length (inch)	Comm Diam (inch)	BEARINGS	
			C.E.	D.E.
916-G	13/16	2.187	a	c
934-D	13/16	2.187	a	c
934-F	13/16	2.187	a	c
934-T	13/16	2.187	a	d
1102667	15/16	1.800	b	b
1102670	15/16	1.800	b	b
1102673	15/16	1.800	b	b
1102674	15/16	1.800	b	b
1102678	15/16	1.800	b	b
1102690	15/16	1.800	a	c
1102691	15/16	1.800	b	b
1102953	15/16	1.800	b	b
1102955	15/16	1.800	b	b
1102956	13/16	1.800	b	b
1102957	13/16	1.800	a	c
1105202	7/8	1.800	a	c
1105529	13/16	2.187	a	c
1105530	13/16	2.187	a	c
1105734	13/16	2.187	a	c
1105778	13/16	2.187	a	c
1105780	13/16	2.187	a	d
1105854	15/16	1.800	b	a
1105859	15/16	1.800	a	c
1105860	15/16	1.800	a	a
1105861	15/16	1.800	a	a
1105862	15/16	1.800	a	a
1105863	15/16	1.800	a	a
1105864	15/16	1.800	a	a
1105866	15/16	1.800	a	a
1105867	15/16	1.800	a	a
1105868	15/16	1.800	a	a
1105902	15/16	1.800	a	a
1105903	15/16	1.800	a	a

- a—Ball Bearing I.D. 0.6693, O.D. 1.5748, Shaft 0.6684–0.6690, End Head 1.576.
- b—Plain Bearing I.D. 0.562–0.563, Shaft 0.5605–0.5610.
- c—Ball Bearing I.D. 0.7274, O.D. 1.8504, Shaft 0.7865–0.7871, End Head 1.8508–1.8513.
- d—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–.09841, End Head 2.4411

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GROUP II GENERATORS—FITS AND TOLERANCES (Cont'd)

Model	Brush Length (inch)	Comm Diam (inch)	BEARINGS	
			C.E.	D.E.
1105906	13/16	1.800	a	d
1106403	13/16	2.187	a	d
1106408	13/16	2.187	a	d
1106453	13/16	2.187	a	d
1106454	13/16	2.187	a	d
1106457	13/16	2.187	a	e
1106458	13/16	2.187	a	e
1106459	13/16	2.187	a	e
1106501	13/16	2.187	a	d
1106502	13/16	2.187	a	d
1106503	13/16	2.187	a	d
1106504	13/16	2.187	a	d
1106505	13/16	2.187	a	d
1106506	13/16	2.187	a	d
1106507	13/16	2.187	a	d
1106539	15/16	1.800	a	f
1106540	13/16	2.187	a	d
1106541	13/16	2.187	a	d
1106542	13/16	2.187	a	d
1106543	13/16	2.187	a	d
1106544	13/16	2.187	a	d

a—Ball Bearing I.D. 0.6693, O.D. 1.5748, Shaft 0.6684–0.6690, End Head 1.576.

d—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–0.9841, End Head 2.4411–2.4419.

e—Ball Bearing I.D. 0.7874, O.D. 2.0472, Shaft 0.7865–0.7871, End Head 2.0475–2.0481.

f—Ball Bearing I.D. 0.9843, O.D. 2.0472, Shaft 0.9836–0.9841, End Head 2.0475–2.0481.

CHAPTER 2
GENERATORS (Cont'd)

Section IV

GROUP III—THIRD-BRUSH, TYPE TWO
HEAVY-DUTY GENERATORS

	Paragraph
Description	23
Cleaning, inspection, and test.....	24
Disassembly	25
Cleaning, inspection, and test of parts.....	26
Repair of parts	27
Assembly of generators	28
Tests and adjustments	29
Fits, tolerances, and data.....	30

23. DESCRIPTION.

a. The generators in this group are all third-brush, type two heavy-duty generators (fig. 2), using ball bearings in both ends with heavy-duty "built-up" reaction type brush holders (figs. 35 through 39). Some generators of this group have shielding connections assembled around the terminals (fig. 41).

24. CLEANING, INSPECTION, AND TEST.

a. Refer to paragraph 6.

25. DISASSEMBLY.

a. **Disassembly Into Main Subassemblies** (fig. 36). **NOTE:** *Where tang type lock washers are used to hold screws or nuts tight, discard on removal and install new tang lock washers on reassembly. It is not safe to use this type washer more than once.*

(1) Loosen cover band screw, and remove cover band. Note relationship of leads and brushes.

(2) Disconnect leads to the insulated and third brush holders by removing screws and lock washers.

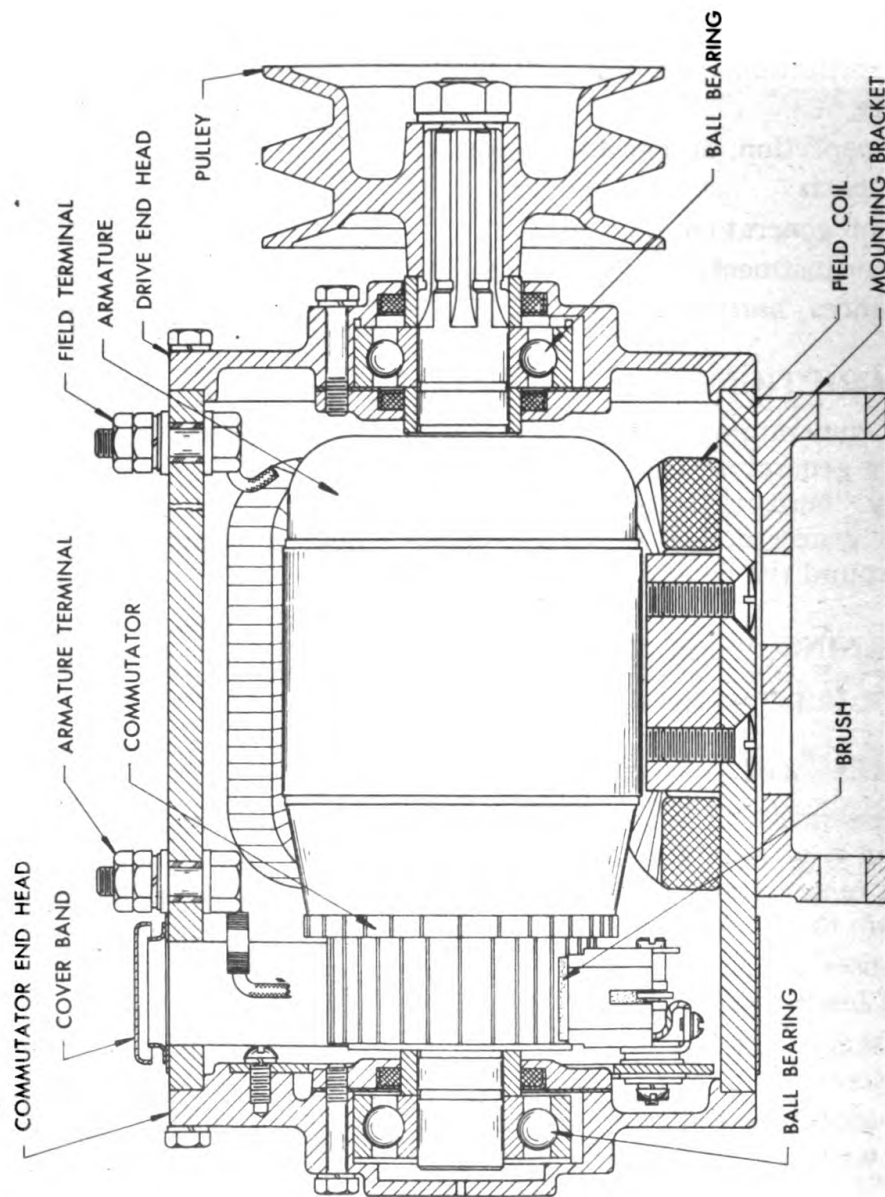
(3) Remove commutator end head by removing attaching screws and lock washers. Loosen the end frame with a soft hammer, if necessary.

(4) Detach field frame from drive end frame by removing six attaching screws and lock washers. Use soft hammer to loosen.

(5) Remove pulley nut and lock washer by placing armature in soft jaws of vise.

(6) With the armature still in soft jaws of vise, use puller to remove pulley from armature shaft.

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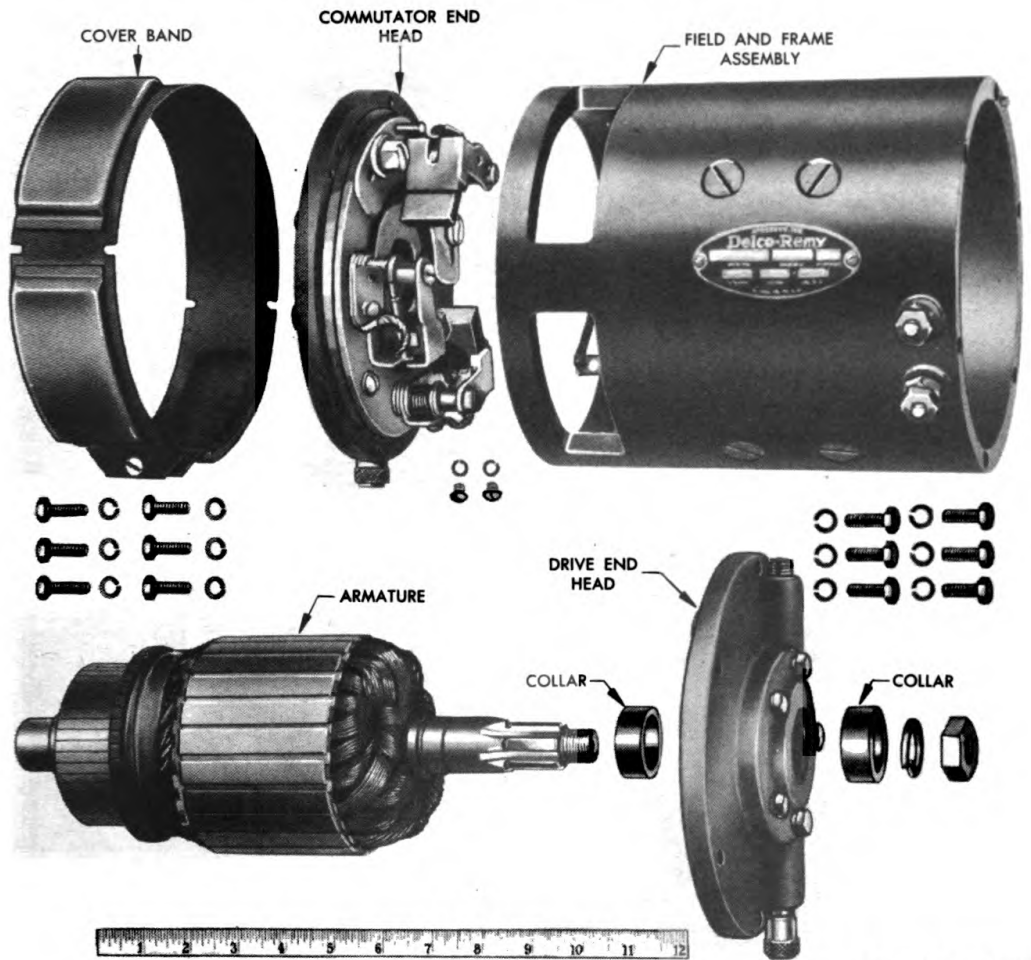
Figure 35—Sectionalized Generator of Heavy-duty Type with Build-up Brush Holders

GROUP III—THIRD-BRUSH, TYPE TWO HEAVY-DUTY GENERATORS

(7) Remove drive end head from armature. While it normally slips off easily, press off if necessary. Remove collars from each side of drive end head.

b. Disassembly of Field Frame (fig. 37).

(1) Detach terminal studs by removing from each terminal stud two each nuts and one each lock washer, plain washer, and insulation washer. The "A" terminal stud may be removed from frame, together with insulating bushing and washer, and main brush lead. The "F" terminal stud is soldered to the field winding lead.

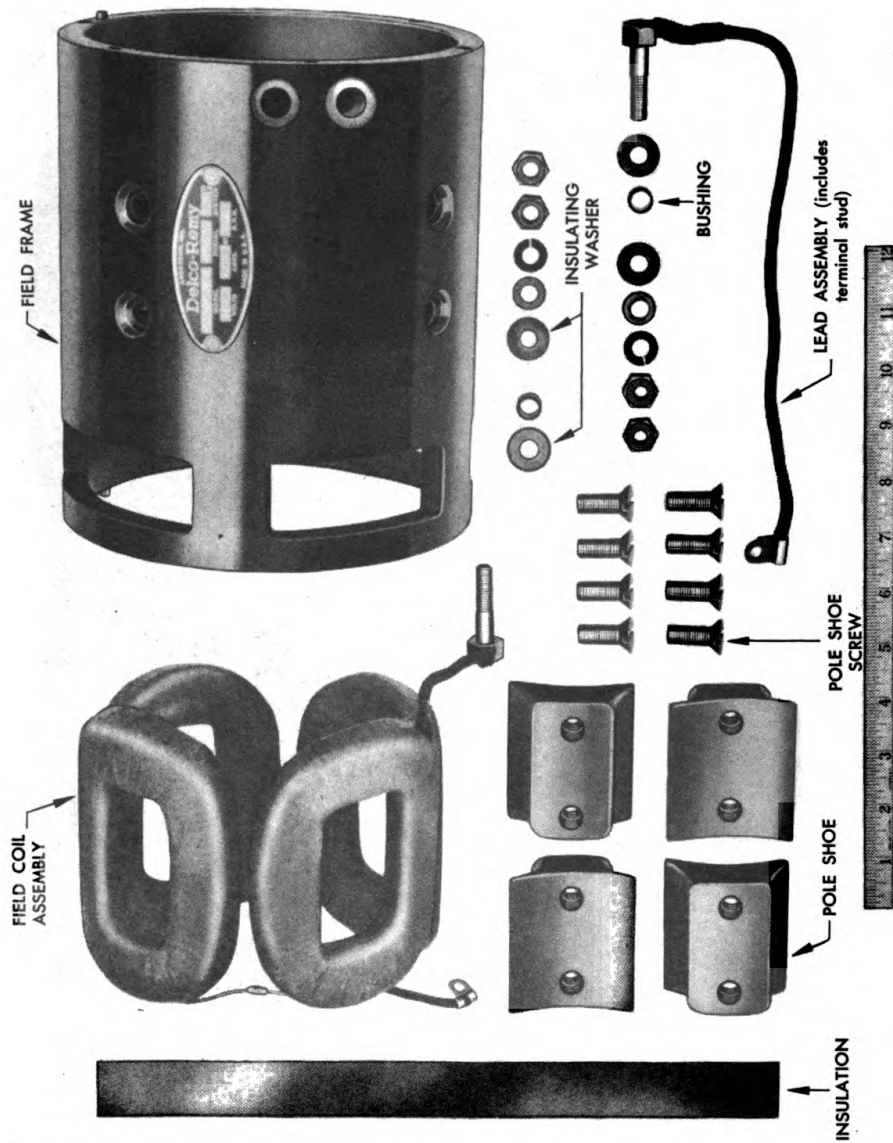


RA PD 312061

Figure 36—Disassembled View of Generator Shown in Figure 35

(2) Remove field windings by removing eight pole shoe screws with pole shoe screwdriver (fig. 17), and lifting out pole shoes and windings. Remove solder and replace stud and clip on field winding leads, if required. Be careful in handling field windings to avoid damaging leads or insulation. **NOTE: Some field coils are varnished and baked in place in the field frame and cannot be removed. If**

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RA PD 312062

Figure 37—Disassembled View of Field Frame

GROUP III—THIRD-BRUSH, TYPE TWO HEAVY-DUTY GENERATORS

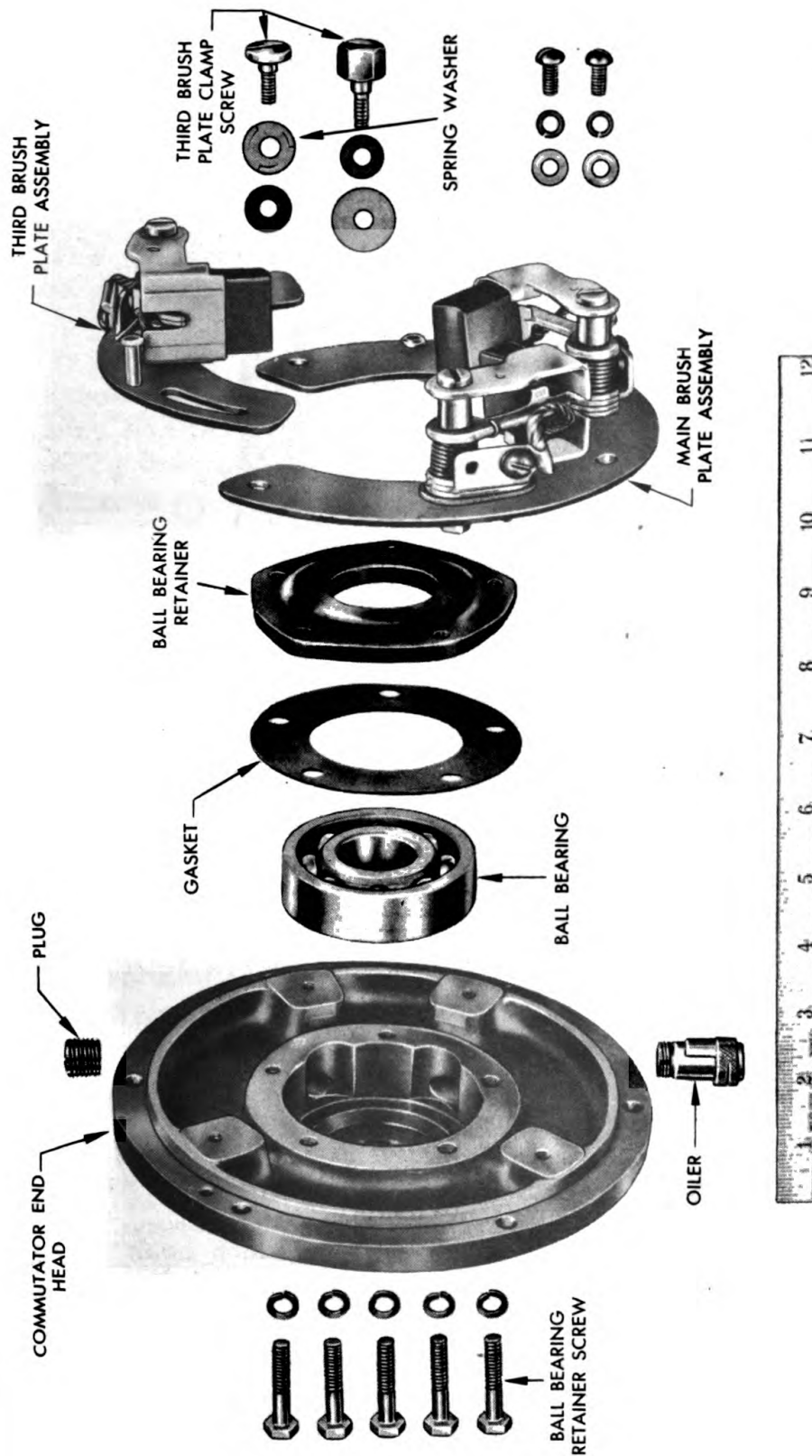


Figure 38—Disassembled View of Commutator End Head

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coils are baked on, they are not serviceable separately. Defective field coils require replacement of field and frame assembly.

c. Disassembly of Commutator End Head (fig. 38).

(1) Remove screws and washers holding the main brush plate to the commutator end head. The hold down screws and washers must be detached. This frees the third brush plate and main brush plate from the commutator end head.

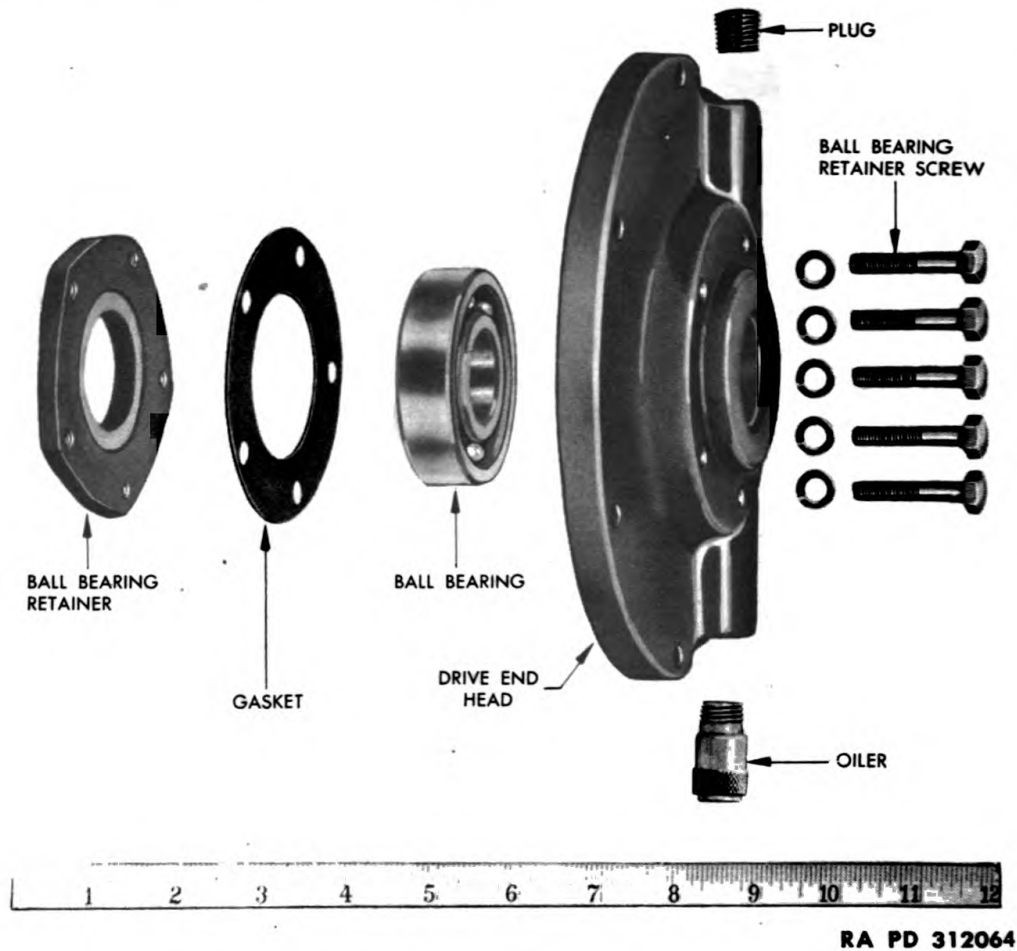


Figure 39—Disassembled View of Drive End Head

(2) Remove the screws and lock washers which hold the ball bearing retainer plate and gasket in place. The felt washer and felt washer retainer are staked in place in the ball bearing retainer plate.

(3) Remove ball bearing from end head.

(4) Disassemble the brush holder assemblies as follows: Remove pigtail lead attaching screw and lock washer from each brush holder and lift out brushes. Detach from each brush holder assembly round head screw and lock washer, brush holder stud, nut, and lock washer.

GROUP III—THIRD-BRUSH, TYPE TWO HEAVY-DUTY GENERATORS

This completely dismantles the brush rigging. Mark the brush holder side of plate for correct reassembly.

(5) Remove oiler and pipe plug from opposite ends of oil passage. **CAUTION:** *These plugs are physically but not functionally interchangeable.* Note on which side oiler was removed so it may be replaced in same position. Wash out passage and oiler and dry with compressed air.

d. Disassembly of Drive End Head (fig. 39).

(1) Detach bearing retainer plate and gasket by removing screws and lock washers. The felt washer and felt washer retainer are staked in place on the bearing retainer.

(2) Remove ball bearing from end head. A felt washer and felt washer retainer are staked in place in the drive end frame on the pulley side of the bearing which serves with the other felt washer to seal the bearing and oil passage.

(3) Remove oiler and pipe plug from opposite ends of oil passage. **CAUTION:** *These plugs are physically but not functionally interchangeable.* Note on which side oiler was installed so it may be replaced in same position. Wash out passage and oiler and dry with compressed air.

26. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 10. **CAUTION:** *Reference is made in paragraph 10 f to plain bearings which are not used in group III generators.*

27. REPAIR OF PARTS.

a. Refer to paragraph 11.

28. ASSEMBLY OF GENERATORS.*

a. Assembly of Field Frame.

(1) Place field coil assembly with pole shoes in field frame. Insert pole shoe spreader (fig. 25), and tighten shoes against frame. Install and tighten pole shoe screws with pole shoe screwdriver (fig. 17). Coil with stud soldered to lead must be so placed that stud can be inserted through hole in frame.

(2) Insert stud on coil lead, with insulating washer and bushing, through "F" terminal hole in frame and secure with insulating washer, plain washer, lock washer, and two nuts. Place stud (with lead attached), insulating washer, and bushing, through "A" terminal hole in frame and secure with insulating washer, plain washer, lock washer, and two nuts.

*When assembling generators that employ the use of tang lock washers, **NEW lock washers must be used.**

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b. Assembly of Commutator End Head.

(1) Reinstall oiler and pipe plug in opposite ends of oil passage.
CAUTION: *Be sure they are replaced in same position as originally.*

(2) Assemble the insulated main brush holder assembly to main brush plate, and insulated third brush holder assembly to third brush plate as follows:

(a) Slide spring on brush arm sleeve, and hook in notch on arm.

(b) Push stud through side of brush holder into space sleeve, through brush arm, and into bushing in other side of holder.

(c) Place brush terminal bracket, space washer, and insulating washer on threaded end of stud. (The third brush assembly does not use the space washer.)

(d) Insert stud through proper hole in plate. Place one small insulating bushing washer, followed by one insulating washer (2 hole—large), one space washer (2 hole—large), lock washer, and nut on stud. Draw nut fingertight.

(e) Place small insulating bushing washer in the other brush mounting screw-hole of the plate and swing brush terminal bracket, space washers, and insulating washers into position.

(f) Line up holes in holder, plate, and washers. Insert and fasten screw with lock washer.

(3) Assemble the grounded brush assembly to the main brush plate as follows:

(a) Slide spring on brush arm sleeve, and hook in notch on arm.

(b) Push stud through side of brush holder into space sleeve, and brush arm into bushing in other side of holder.

(c) Place brush terminal bracket and two space washers on threaded end of stud.

(d) Insert stud through small hole, of a group of two holes, in brush plate.

(e) Place space washer, lock washer, and nut, on stud and draw fingertight.

(f) Swing brush terminal bracket into place so that holes aline in bracket, washers, and brush plate.

(g) Secure with screw and lock washer.

(4) Install ball bearing in end head.

(5) Install the ball bearing retainer plate, including felt washer and its cup retainer, and gasket to the end frame with the five attaching screws and lock washers.

(6) Attach the main brush plate assembly to the end head with two screws, lock washers, and plain washers. Turn as far as possible in direction counter to normal armature rotation before tightening screws. Attach the third brush plate to the main brush plate and end head with the two hold-down screws, lock washers, and plain washers. (The upper hold-down screw uses a spring washer instead of lock washer.)

GROUP III—THIRD-BRUSH, TYPE TWO HEAVY-DUTY GENERATORS

(7) Install brushes and attach pigtail leads to brush holders with screw and lock washer (one each).

c. Assembly of Drive End Head.

(1) Install oiler and pipe plug in opposite ends of oil passage. **CAUTION:** *Be sure they are replaced in same position as originally.*

(2) Install ball bearing in drive end head. Use an arbor press, if necessary.

(3) Attach ball bearing retainer (which includes felt washer, and felt washer cup retainer), and gasket, to end frame with the five attaching screws and lock washers.

d. Assembly of Generator.

(1) Place the correct collar on the armature shaft, and slip drive end head on shaft. Use an arbor press if necessary.

(2) Place the collar and pulley on the splined shaft, and with the armature in the soft jaws of a vise, secure in place with pulley nut and lock washer.

(3) Attach field frame assembly to drive end head with six attaching screws and lock washers.

(4) Attach commutator end head to field frame with six attaching screws and lock washers.

(5) Connect leads to the insulated and third brush holders with one each, screw and lock washer. This connects the "A" terminal to the insulated main brush and the "F" terminal, through the field windings to the insulated third brush.

e. **Installation of Safety Wire.** Install safety wire through holes in screws, and twist ends together. Where safety wire is used inside generator, the safety wire must be installed before final assembly.

29. TESTS AND ADJUSTMENTS.

a. Mount generator on test stand, connect to test stand ammeter and voltmeter. Connect the ammeter in the charging circuit at the "A" terminal. Connect the voltmeter leads from the generator "A" terminal to ground, and bridge the generator "A" and "F" terminals with a jumper lead. Operate generator at speed at which maximum output is obtained. If output exceeds maximum specified cold generator output, immediately remove cover band, loosen third-brush hold-down screw in commutator end head with offset screwdriver. Move third brush away from main brush to obtain specified cold output. Generator must be checked at specified voltage, since the output varies with the voltage. If specified voltage cannot be attained, $\frac{1}{4}$ ohm variable resistance, of sufficient current carrying capacity, must be inserted into the charging circuit and resistance cut in until the specified voltage is attained. Operate until generator reaches operating temperature (about 30 minutes), and check hot output. Adjust by moving the third brush toward the main brush to increase output, or move third brush away from main brush to lower output. After adjustment is complete, tighten the hold-down screw and replace cover band.

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ELECTRICAL EQUIPMENT (DELCO-REMY)**

30. FITS, TOLERANCES, AND DATA.
a. Test Data.

TEST SPECIFICATIONS FOR GROUP III GENERATORS
Brush Spring Tension—25 oz

Model	Rotation	Field Current at 6 Volts (amps)	COLD OUTPUT		HOT OUTPUT	
			Amps	Volts	Amps	Volts
417	C	1.35-1.48*	24-26	13	18	13
440	CC	1.39-1.47*	24-26	13	18	13
550	C	1.35-1.48*	24-26	13	18	13
555	C	1.35-1.48*	24-26	13	18	13
557	C	1.39-1.47*	13-15	13	10	13
561	CC	1.39-1.47*	24-26	13	18	13
674	C	3.53-3.75	28-30	7	22-24	7
677	CC	1.39-1.47*	24-26	13	18	13
687	C	1.35-1.48*	24-26	13	18	13
695	C	1.35-1.48*	24-26	13	18	13
1117002	CC	1.35-1.48*	24-26	13	18	13
1117011	C	3.53-3.75	28-30	7	22-24	7
1117014	C	1.39-1.47*	13-15	13	10	13
1117018	C	1.35-1.48*	24-26	13	18	13
1117020	C	1.35-1.48*	24-26	13	18	13
1117036	C	1.39-1.47*	13-15	13	10	13

* Field current at 12 volts.
C—Clockwise rotation viewing drive end.
CC—Counterclockwise rotation viewing drive end.

GROUP III—THIRD-BRUSH, TYPE TWO HEAVY-DUTY GENERATORS

b. Fits and Tolerances.

GROUP III GENERATORS—FITS AND TOLERANCES

Nomenclature:

C.E.—Commutator End
 Comm Diam—Commutator Diameter
 D.E.—Drive End
 I.D.—Inside Diameter
 O.D.—Outside Diameter

Model	*Main Brush Length (inch)	Comm Diam (inch)	BEARINGS	
			C.E.	D.E.
417	1 $\frac{3}{32}$	2.990–3.000	a	a
440	1 $\frac{3}{32}$	2.990–3.000	a	b
550	1 $\frac{3}{32}$	2.990–3.000	a	a
555	1 $\frac{3}{32}$	2.990–3.000	a	b
557	1 $\frac{3}{32}$	2.990–3.000	a	a
561	1 $\frac{3}{32}$	2.990–3.000	a	b
674	1 $\frac{3}{32}$	2.990–3.000	a	a
677	1 $\frac{3}{32}$	2.990–3.000	a	a
687	1 $\frac{3}{32}$	2.990–3.000	a	b
695	1 $\frac{3}{32}$	2.990–3.000	a	a
1117002	1 $\frac{3}{32}$	2.990–3.000	a	b
1117011	1 $\frac{3}{32}$	2.990–3.000	a	a
1117014	1 $\frac{3}{32}$	2.990–3.000	a	a
1117018	1 $\frac{3}{32}$	2.990–3.000	a	a
1117020	1 $\frac{3}{32}$	2.990–3.000	a	a
1117036	1 $\frac{3}{32}$	2.990–3.000	a	a

*Third-brush length for all models is one inch.

a—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–0.9841, End Head 2.4411–2.4419.

b—Ball Bearing I.D. 1.1811, O.D. 2.4409, Shaft 1.1801–1.1807, End Head 2.4411–2.4419.

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CHAPTER 2
GENERATORS (Cont'd)

Section V

GROUP IV—TWO OR FOUR-BRUSH SHUNT,
TYPE TWO HEAVY-DUTY GENERATORS

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Cleaning, inspection, and test	32
Disassembly	33
Cleaning, inspection, and test of parts	34
Repair of parts	35
Assemble generator	36
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31. DESCRIPTION.

a. The generators in this group are all two-brush or four-brush shunt, type two (fig. 2), heavy-duty generators, using ball bearings in both ends with heavy-duty, reaction type brush holders (figs. 40 through 49). Some have shielded connections assembled around the terminals (fig. 41), while others use the terminal box type shielding (fig. 42). Bearings may or may not be of the sealed type.

32. CLEANING, INSPECTION, AND TEST.

a. Refer to paragraph 16. *NOTE: All generators in group IV are type two units (fig. 2). Use testing procedure for type two generators only, as outlined in paragraph 16.*

33. DISASSEMBLY.

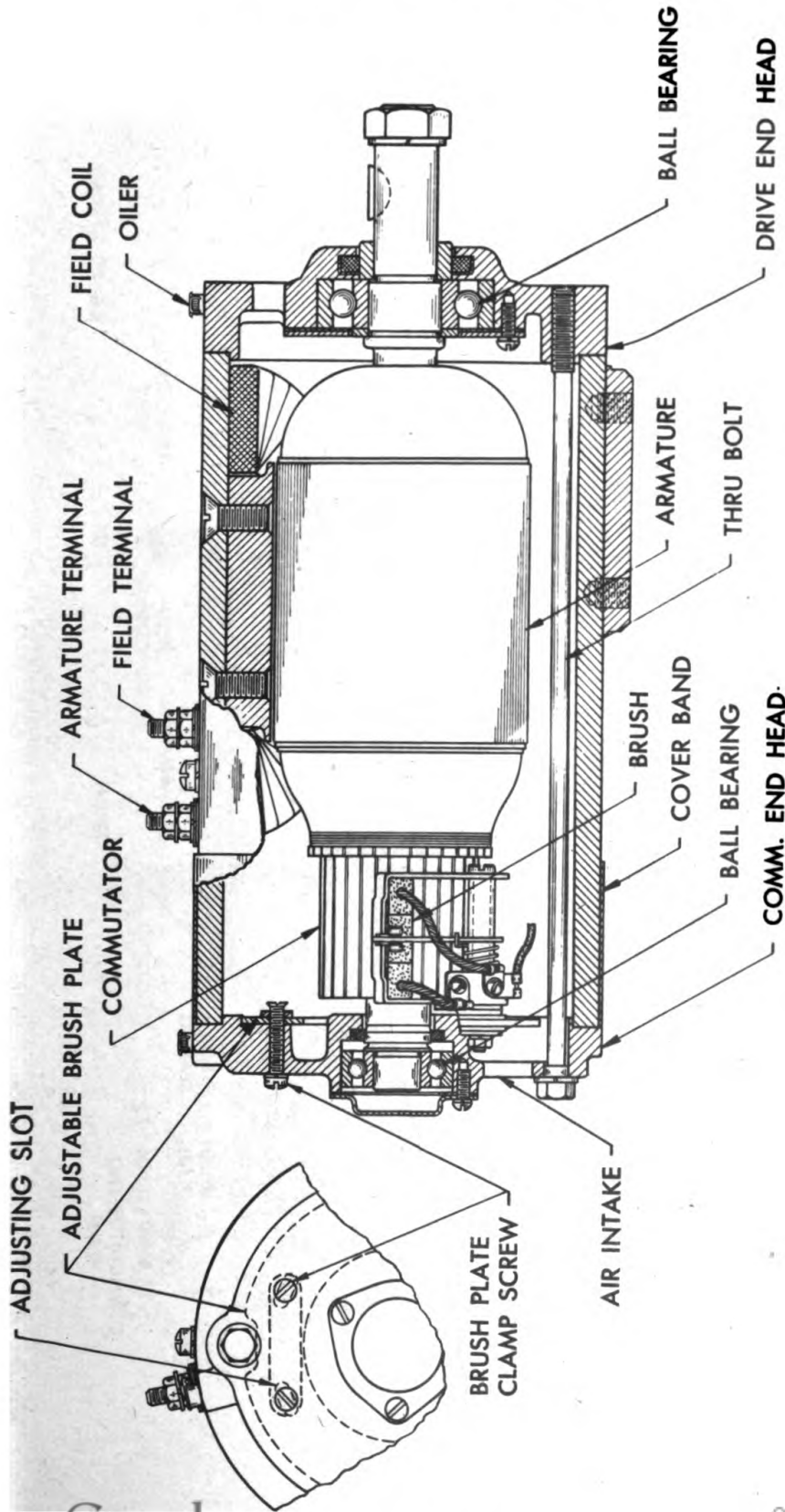
a. **Disassembly Into Main Subassemblies*** (figs. 43 and 44).

- (1) Loosen screw or snap back catch, and remove cover band.
- (2) Disconnect insulation covered lead or leads from insulated brush holder (or holders), by removing screws and washers.
- (3) On type generator with through bolts (fig. 43), remove through bolts. On type in figure 44, bend down locking tangs on lock washers, and remove screws and lock washers. Remove commutator end head from field frame. Loosen end head with soft hammer, if necessary.

(4) On type generator with through bolts, detach field frame. On type shown in figure 44, bend down locking tangs on lock washers,

**Tang type lock washers are used to hold screws or nuts tight. They must be discarded on removal, and new tang lock washers installed on reassembly. It is not safe to use this type washer more than once.*

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Figure 40—Sectional View of Heavy-duty, Two-brush, Shunt Generator

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(3) If bearing does not come out readily, remove in arbor press.

(4) Disassemble brush plate assembly as follows (fig. 48): Remove grounded brush holders by detaching brush lead clips and brushes (removing screw and lock washer with screwdriver) and removing nut, screw, two lock washers, and one flat two-hole washer from the rear side of the brush plate. The brush holder stud, space sleeve, brush arm, brush spring, bushing, brush holder, brush terminal

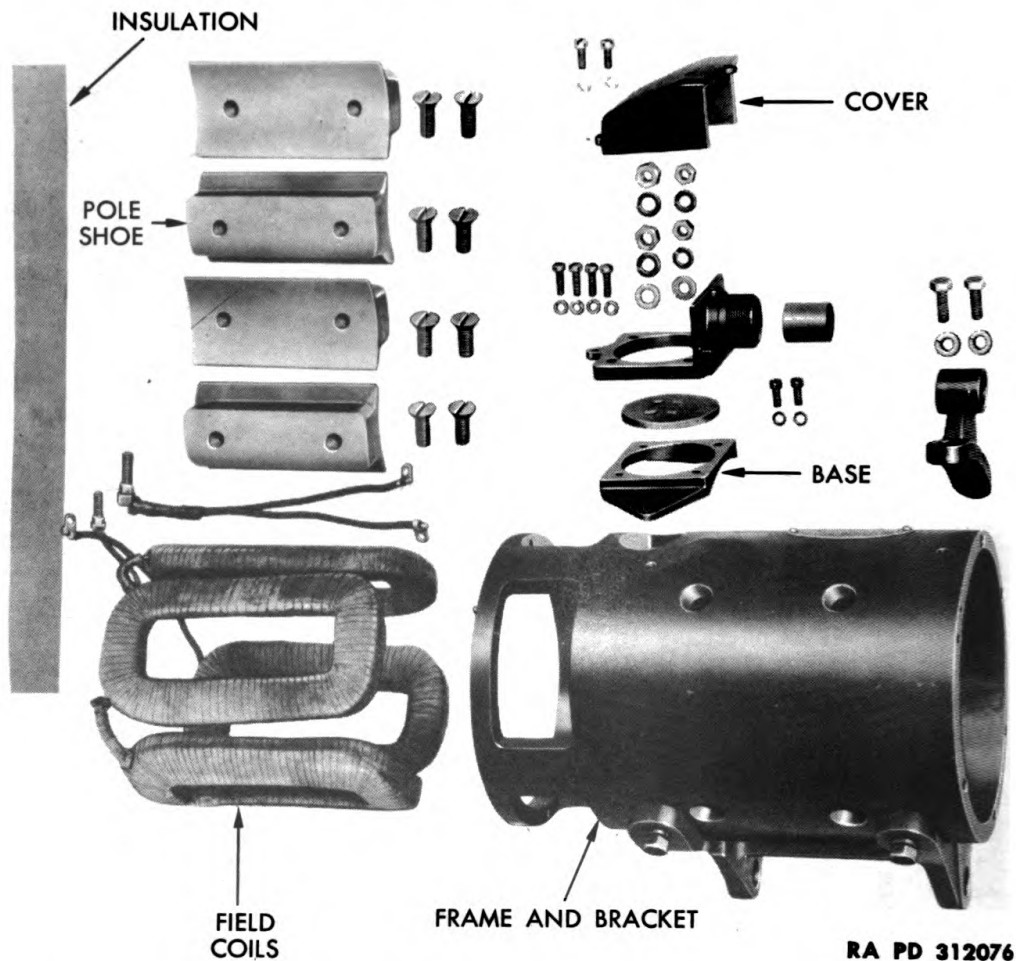


Figure 51—Disassembled View of Field Frame of Generator Shown in Figure 42

bracket, and two two-hole flat washers will come off, in order named. Insulated brush holders are removed in identical manner, except that on the rear side, a two-hole insulating washer and two insulating bushings have been added, while on the brush holder side, a two-hole insulating washer has been substituted for one of the two-hole flat metallic washers. During disassembly, note very carefully which side of the plate the holders are attached to, so that, on reassembly, the holders will be fastened to the right side of the plate.

**GROUP IV—TWO OR FOUR-BRUSH SHUNT,
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d. Disassemble Field Frame (figs. 49, 50, and 51).

(1) Where terminal studs are used, either with or without shields (figs. 49 and 50), detach by removing nuts, washers, and insulators. Push studs through field frame.

(2) Where condensers are installed in frame, remove for test, if necessary. Follow instructions on tester for testing condensers.

(3) Where terminal box is used (fig. 51), disassemble as follows:

(a) Remove two screws, lock washers, and terminal cover. Note relationship of studs so they may be reassembled in same positions.

(b) Remove two nuts, lock washers and flat washers, from "A" and "F" terminals, and push terminal studs out of fiber terminal mounting plate.

(c) Remove four screws and lock washers holding terminal box and support in place. Press the fiber terminal support out of the box if it requires replacement.

(d) Remove two screws and lock washers holding terminal box base to frame if base requires replacement.

(4) Remove pole shoe screws, pole shoes, and field coil assembly. Unsolder old terminal stud and clip, and solder new stud or clip, if required, using rosin flux. *NOTE: Many of these units have field coils that are varnished and baked in place in the field frame, and cannot be removed. If field coils are baked in, they are not serviceable separately so that when coils are defective, replacement of field and frame assembly will be required.*

34. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 10 which applies to group IV generators with one exception. Some of the armatures used in this group are so connected that they cannot be tested satisfactorily on the growler for short circuits. On such units, satisfactory operation, as determined by ability of generator to produce rated output at specified speed is sufficient evidence that armature is not shorted.

35. REPAIR OF PARTS.

a. Refer to paragraph 11 which applies to group IV generators with the exception that some of the generators used in group IV have the armature conductors welded to the commutator riser bars and they cannot be resoldered.

36. ASSEMBLE GENERATOR.*

a. Assemble Field Frame.

(1) Assemble field coils and pole shoes in field frame. The studs must be adjacent to the window or openings in field frame through which the terminals mount. Use pole shoe spreader to bring pole shoes up tightly against field frame (fig. 22), and use pole shoe screwdriver to put pole shoes into place (fig. 17).

(2) On type with terminal box (fig. 51) proceed as follows:

**Use new tang lock washers if generator is assembled with this type washer. Never use old tang lock washer.*

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(a) Fasten terminal box base with two screws and lock washers to field frame.

(b) Assemble terminal support plate into terminal box and attach to base with four screws and lock washers. Be sure to re-assemble in original position as noted before disassembly.

(c) Push terminal studs through support plate and fasten with flat washer, lock washer, nut, lock washer and nut, in order named.

(d) Fasten terminal cover to terminal box with two screws and lock washers.

(3) Where condensers are used in field frame, install them.

(4) Where terminal studs are used, push them through field frame with insulators in place and secure with washers and nuts. Include terminal shields if used. See figures 40, 41, 49 and 50 for assembly of parts.

b. Assembly of Commutator End Head.

(1) Be sure to attach the brush holders to the correct side of the brush plate (par. 33). Attach insulated brush holders by placing bushings in brush plate holes with two-hole insulating washers on each side. Place lock washer and two-hole flat washer on screw, put screw through proper bushing in plate, add two-hole washer, brush terminal bracket, and brush holder. Run screw up tight into tapped hole in brush holder. Start brush holder stud into brush holder, adding space sleeve, brush arm, spring, and stud bushing, in relationship shown in figures 43 or 44. The straight end of spring should lie in the angle of the brush terminal bracket, while the hooked section must be caught with pliers and hooked into the notch on the back of the brush arm. Put lock washer on end of tapped section of stud, and secure with stud nut. Attach the two grounded brush holders in the same manner, with the exception that there are no insulating washers nor bushings. Two two-hole metallic washers are used on brush holder side of plate. Put brushes in holders, and attach lead clips with screws and lock washers.

(2) Put ball bearing into end frame, using arbor press if necessary. Secure by fastening the gasket and bearing cover plate on the outside, and the retainer plate assembly and gasket on the inside, with screws and lock washers.

(3) Fasten brush plate assembly to frame with screws and lock washers. On type generator shown in figures 41 or 42, observe the proper relationship as established by the two dowel pins in the end frame and the two notches in the outer diameter of the brush plate. On the type shown in figure 37, plate will fit into frame in one position only because of difference in radius of attaching screw slots.

c. Assemble Drive End Head.

(1) While the bearing usually slips into head easily, it may have to be pressed in with arbor press.

(2) Install bearing retainer plates and gaskets (if used) on one or both sides of frame head with screws and lock washers.

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d. Assemble Generator.

(1) Place drive end head on armature shaft, using arbor press if necessary.

(2) Place space collar on shaft (where used), and press pulley into position on armature shaft in arbor press. Secure with washer and nut, holding armature in soft jaws of vise. Secure nut with cotter pin where used.

(3) Place field frame on armature in proper position so dowel and hole aline. Secure assembly with screws and lock washers where generator is type shown in figures 41 or 42.

(4) Place commutator end head in position so dowel and hole aline, pressing on if required. Assemble with through bolts where assembly is type shown in figure 40 or where type is as shown in figures 41 or 42, secure with screws and lock washers.

(5) Connect leads to insulated brush holders with screws and lock washer.

(6) Put cover band in position, and snap catch or tighten screw to secure.

e. Install safety wire through holes in screws (where present), and twist ends together. Where safety wire is used inside the generator, or on retainer plate screws or similar places, the safety wire must be installed before final assembly.

37. TESTS AND ADJUSTMENTS.

a. Preliminary Procedure. Refer to paragraph 21.

b. Neutral Point. One adjustment that is made on the generator is the setting for "neutral point." Check this after replacing an armature, or when reassembling the machine after an overhauling. It is imperative that the correct relations exist in the alinement of the field coils, the armature windings and the brushes. This alinement is checked by impressing battery voltage through the armature by connecting battery leads to the "A" terminal and ground, and noting the tendency for rotation in the armature. Mount generator on test bench with armature free to rotate and all wires disconnected from the field terminal. The voltage to use in making this check is the minimum amount which will cause the armature to rotate when it is free to turn. This voltage is obtained by using a variable resistance in the line. Use as low a voltage as possible and never use voltage higher than rated generator voltage. The "neutral point" is found by shifting the brushes into the position at which there is no tendency for the armature to rotate in either direction. To shift the brushes, it is first necessary to loosen the brush plate lock screws on the commutator end head either with an offset or plain screwdriver according to whether they are on inside or outside. Loosen screws enough to allow movement of the brush plate. For best performance of the generator, set brushes slightly ahead of neutral. This means that with voltage impressed on the armature, the armature should tend to rotate very slowly in the direction of the generator's normal driven rotation. Moving the brush plate assembly

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in the direction of normal rotation tends to put the machine ahead of neutral. Moving the brush plates against the direction of normal rotation tends to put the machine behind neutral. Be sure that the brush plate lock screws are tightened securely after adjustment is complete.

38. FITS, TOLERANCES, AND DATA.

a. Test Data.

TEST SPECIFICATIONS FOR GROUP IV GENERATORS

Brush Spring Tension—25 oz

Model	Rotation	Field Current at 6 Volts	Amps	Cold Output [●] Volts	Approx RPM
692	C	1.26-1.33*	40	13.0	1250
950	C	1.09-1.20*	50	13.0	1700
952	C	1.54-1.71*	54	13.0	1000
966	C	1.54-1.71*	54	13.0	1000
983	C	1.54-1.71*	54	13.0	1000
984	C	1.54-1.71*	54	13.0	1000
985	C	1.54-1.71*	54	13.0	1000
993	C	1.54-1.71*	55	13.0	950
995	C	0.76-0.84†	50	26.0	1670
998	C	0.76-0.84†	50	26.0	1670
999	CC	0.76-0.84†	50	26.0	1670
1106584	C	1.54-1.67	40	7.5	1080
1106593	C	0.91-0.98	35	8.0	1400
1106631	C	1.2-1.27*	25	13.0	1300
1106635	CC	1.2-1.27*	25	13.0	1300
1106638	C	1.2-1.27*	25	13.0	1300
1106647	C	1.2-1.27*	25	13.0	1300
1106654	C	1.2-1.27*	25	13.0	1300
1106656	CC	1.2-1.27*	25	13.0	1300
1106658	C	1.2-1.27*	25	13.0	1300
1106659	C	1.2-1.27*	25	13.0	1300
1106660	C	1.2-1.27*	25	13.0	1300
1117032	C	1.26-1.33*	18	13.0	800
1117034	C	1.26-1.33*	18	13.0	800
1117040	C	0.91-1.03 [▲]	14	32.0	1250
1117041	C	1.26-1.33*	40	13.0	1250
1117042	CC	1.26-1.33*	40	13.0	1250
1117205	C	1.28-1.39 [▲]	20	35.0	900
1117207	C	0.96-1.05†	25	24.0	1300
1117208	CC	0.96-1.05†	25	24.0	1300
1117211	C	0.96-1.05†	25	24.0	1300
1117218	CC	0.78-0.84 [▲]	25	35.0	1550
1117220	C	0.96-1.05†	25	24.0	1300
1117301	C	0.76-0.84†	50	26.0	1670
1117303	CC	0.76-0.84†	50	26.0	1670
1117304	CC	0.76-0.84†	50	26.0	1670
1117305	CC	1.54-1.71*	55	13.0	950
1117307	C	1.54-1.71*	55	13.0	950
1117308	C	1.54-1.71*	55	13.0	950
1117547	C	0.55-0.60†	50	26.0	985
1117550	C	0.55-0.60†	50	26.0	985
1117551	C	0.55-0.60†	50	26.0	985

*Field current at 12 volts. †Field current at 24 volts. [▲]Field current at 32 volts.

[●]Output at given speed—Not necessarily maximum output. Maximum output controlled by current regulator.

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b. Fits and Tolerances.

GROUP IV GENERATORS

Nomenclature:

C.E.—Commutator End
Comm Diam—Commutator Diameter
D.E.—Drive End
I.D.—Inside Diameter
O.D.—Outside Diameter

Model	Brush Length (inch)	Comm Diam (inch)	BEARINGS	
			C.E.	D.E.
692	1.0	3.000	a	a
950	1.0	3.000	a	a
952	1.0	3.000	a	d
966	1.0	3.000	a	d
983	1.0	3.000	a	d
984	1.0	3.000	a	d
985	1.0	3.000	a	d
993	1.0	3.000	a	d
995	1.0	3.000	a	a
998	1.0	3.000	a	a
999	1.0	3.000	a	a
1106584	1.0	2.187	b	a
1106593	1.0	2.187	b	a
1106631	1.0	2.187	b	a
1106635	1.0	2.187	b	a
1106638	1.0	2.187	b	a
1106647	1.0	2.187	b	a
1106654	1.0	2.187	b	a
1106656	1.0	2.187	b	a
1106658	1.0	2.187	b	a
1106659	1.0	2.187	b	a
1106660	1.0	2.187	b	a
1117032	1.0	3.000	a	a
1117034	1 $\frac{3}{32}$	3.000	a	a
1117040	1.0	3.000	a	a
1117042	1.0	3.000	a	a
1117205	1.0	3.000	a	a
1117207	1.0	3.000	a	d
1117208	1.0	3.000	a	a
1117211	1.0	3.000	a	a
1117218	1.0	3.000	a	a

a—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–0.9841, End Head 2.4411–2.4419.

b—Ball Bearing I.D. 0.6693, O.D. 1.5748, Shaft 0.6684–0.6690, End Head 1.575–1.576.

d—Ball Bearing I.D. 0.9843, O.D. 3.1496, Shaft 0.9836–0.9841, End Head 3.1500–3.1506.

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Model	Brush Length (inch)	Comm Diam (inch)	BEARINGS	
			C.E.	D.E.
1117220	1.0	3.000	a	a
1117301	1.0	3.000	a	d
1117303	1.0	3.000	a	d
1117304	1.0	3.000	a	d
1117305	1.0	3.000	a	d
1117307	1.0	3.000	a	d
1117308	1.0	3.000	a	d
1117547	1.0	3.812	c	e
1117550	1.0	3.812	c	c
1117551	1.0	3.812	c	c

a—Ball Bearing I.D. 0.9843, O.D. 2.4409, Shaft 0.9836–0.9841, End Head 2.4411–2.4419.

c—Ball Bearing I.D. 1.1811, O.D. 2.8346, Shaft 1.1805–1.1809, End Head 2.8351–2.8356.

d—Ball Bearing I.D. 0.9843, O.D. 3.1496, Shaft 0.9836–0.9841, End Head 3.1500–3.1506.

e—Ball Bearing I.D. 1.1811, O.D. 3.5433, Shaft 1.1805–1.1809, End Head 3.5439–3.5443.

CHAPTER 3 REGULATORS

Section I

BASIC PRINCIPLES OF OPERATION

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39. CONSTRUCTION.

a. All regulators have a cut-out relay, plus either a step-voltage control or a vibrating voltage regulator. On three-unit regulators, a current regulator is also included with the vibrating voltage regulator and cut-out relay. All units are mounted on the same base and enclosed by the same cover.

40. FUNCTION.

a. The cut-out relay opens and closes the circuit between the generator and battery. It closes the circuit when the generator operates to charge the battery, and opens the circuit when the generator is not operating to prevent the battery from discharging back through the generator. The step-voltage control, voltage regulator, and current regulator, control generator output under varying conditions of operation.

41. OPERATION OF CUT-OUT RELAY.

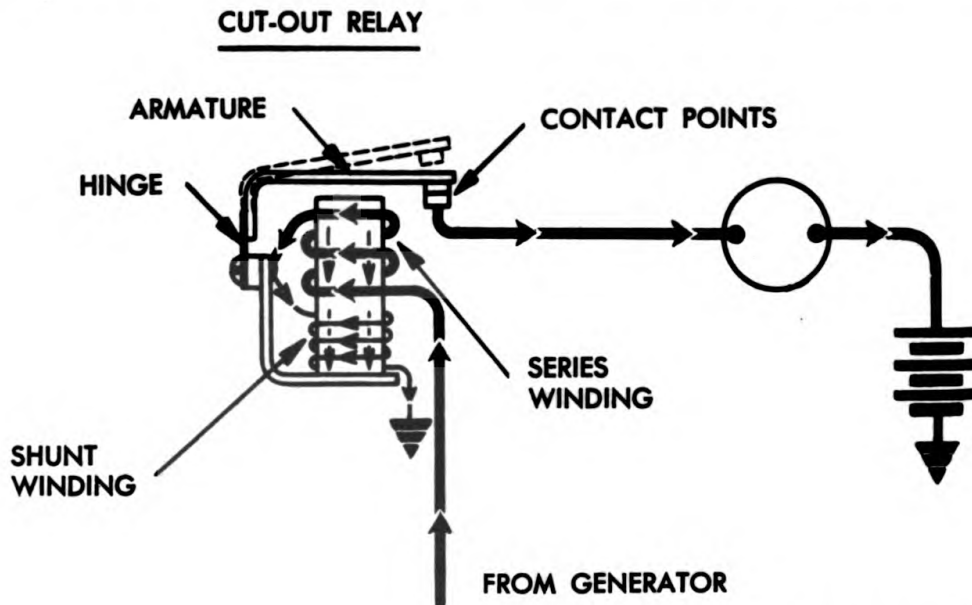
a. The cut-out relay (fig. 52) consists of two windings, a shunt winding and a series winding, assembled on a single core, above which is placed an armature. The shunt winding consists of many turns of fine wire, and is connected across the generator. The series winding consists of a few turns of heavy wire designed to carry full generator output, and it is connected into the charging circuit. The armature carries a point which is positioned above a stationary matching point. When the generator is not operating, the armature is held away from the winding core by spring tension, and the points are separated. As soon as the generator begins to operate at a speed sufficient to produce enough voltage to charge the battery, this voltage, which is impressed on the relay windings, creates enough magnetism to overcome the armature spring tension and close the points. So long as the generator charges the battery, the points are held closed. When the generator slows or stops so that current flows

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from the battery to the generator, the points open. They open because the series winding magnetic field reverses as the current in it reverses so that the two windings no longer help each other. The magnetic fields buck, causing a reduction of the total magnetic field to a point where it can no longer hold the armature down and the points closed. The spring tension pulls the armature up and opens the points.

42. OPERATION OF STEP-VOLTAGE CONTROL.

a. The step-voltage control (fig. 53) is a magnetic switch that automatically inserts or removes resistance in the generator field



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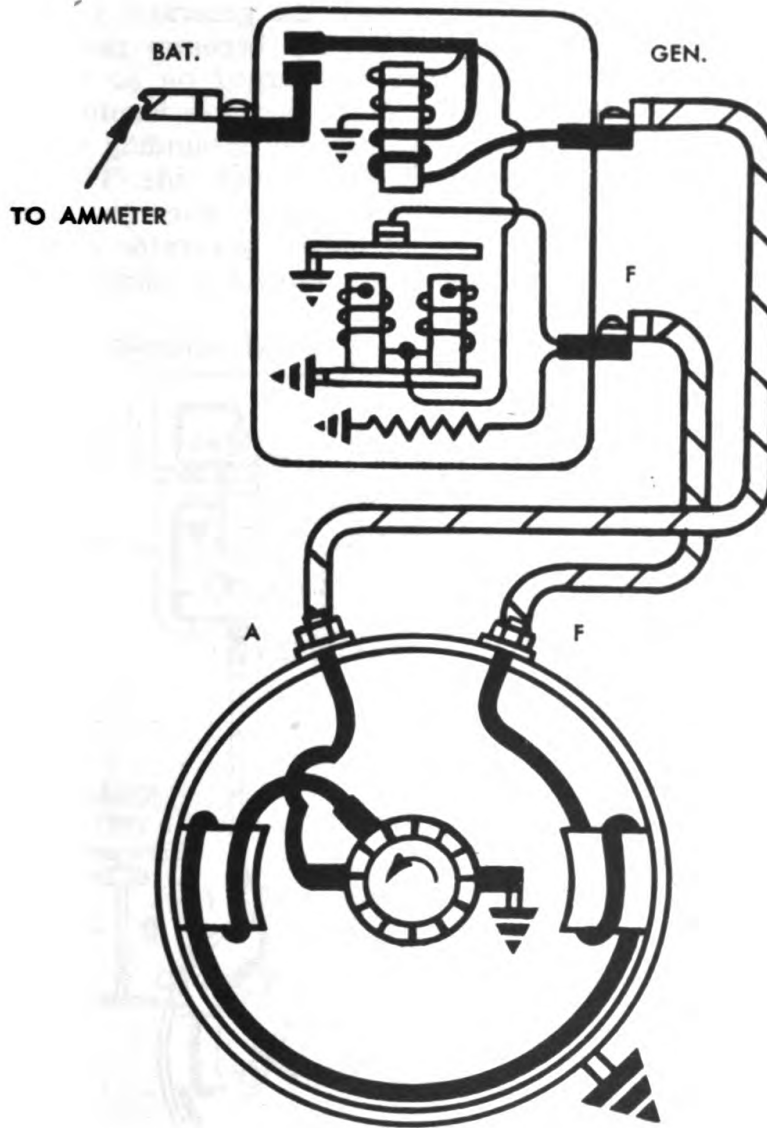
Figure 52—Schematic Wiring Circuit of Cut-out Relay

circuit. When the battery is low, the step-voltage control keeps the resistance out of the generator field circuit so the generator can produce full output as determined by the third brush setting. When the battery comes up to charge, the step-voltage control inserts resistance into the generator field circuit, thus causing the generator output to be reduced to a low value, so that battery overcharge and high voltage are avoided.

b. The step-voltage control consists of two windings assembled on two cores, connected in series and, together, shunted across the generator, and an armature with a pair of contact points held closed by spring tension. In this position the generator field circuit is conducted directly to ground through the points. Full generator output

BASIC PRINCIPLES OF OPERATION

STEP-VOLTAGE CONTROL



GENERATOR

RA PD 312078

Figure 53—Schematic Wiring Diagram of Step-voltage Control

is thus available. As the battery approaches a charged condition, its charging voltage increases. This increasing voltage, energizing the two windings, becomes great enough when the battery is sufficiently charged, to cause the voltage control unit to operate. At this point, the voltage is great enough to create sufficient magnetic strength in the winding cores to overcome the armature spring tension, and pull the armature toward the core so that the contact points open. With the points open, the generator field current must go to ground through a resistance. Generator field current and output are consequently reduced. So long as the battery remains in a charged condition and line voltage is high, then the resistance

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remain in the generator field circuit. Then the generator continues to operate on low output. When the battery becomes partly discharged, or when electrical accessories are turned on so that the line voltage is reduced, the lowered voltage becomes insufficient to hold the points open. The points close, directly grounding the field so that the generator output comes up on the high side. There are, in effect, two generators, a standard output unit when the battery and line voltage is low, and a reduced output generator when the battery is up to charge and less generator output is required.

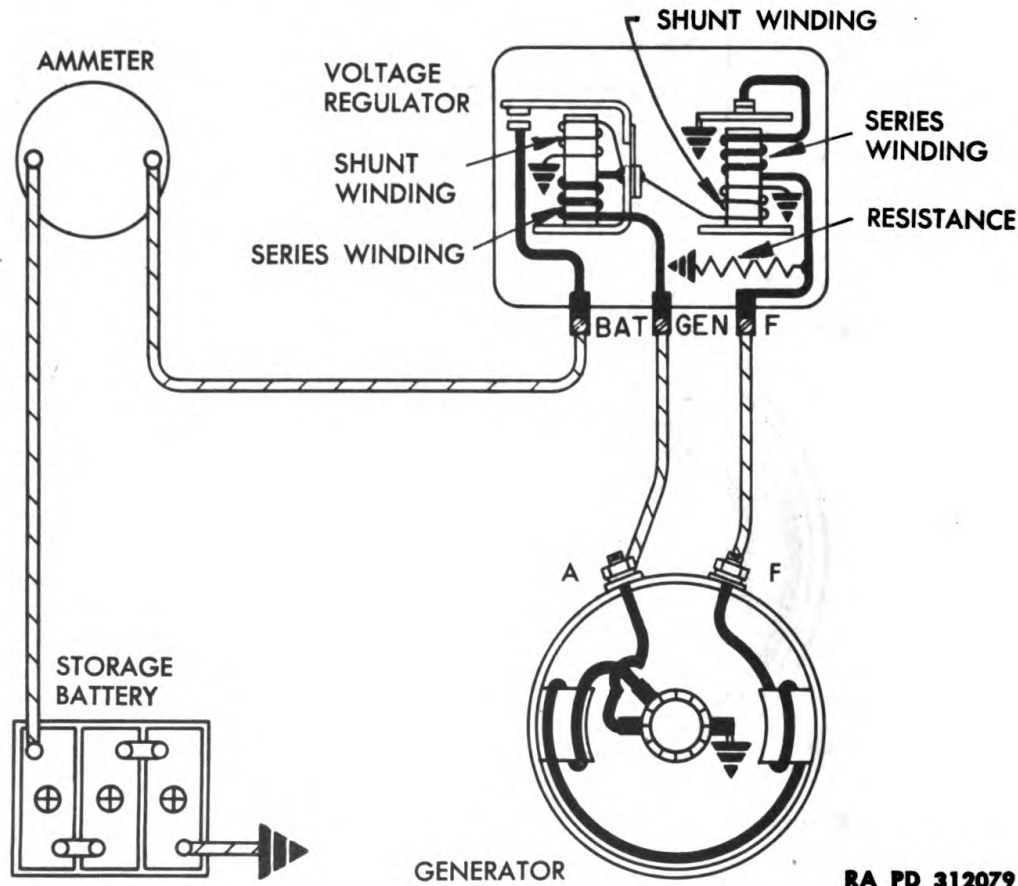


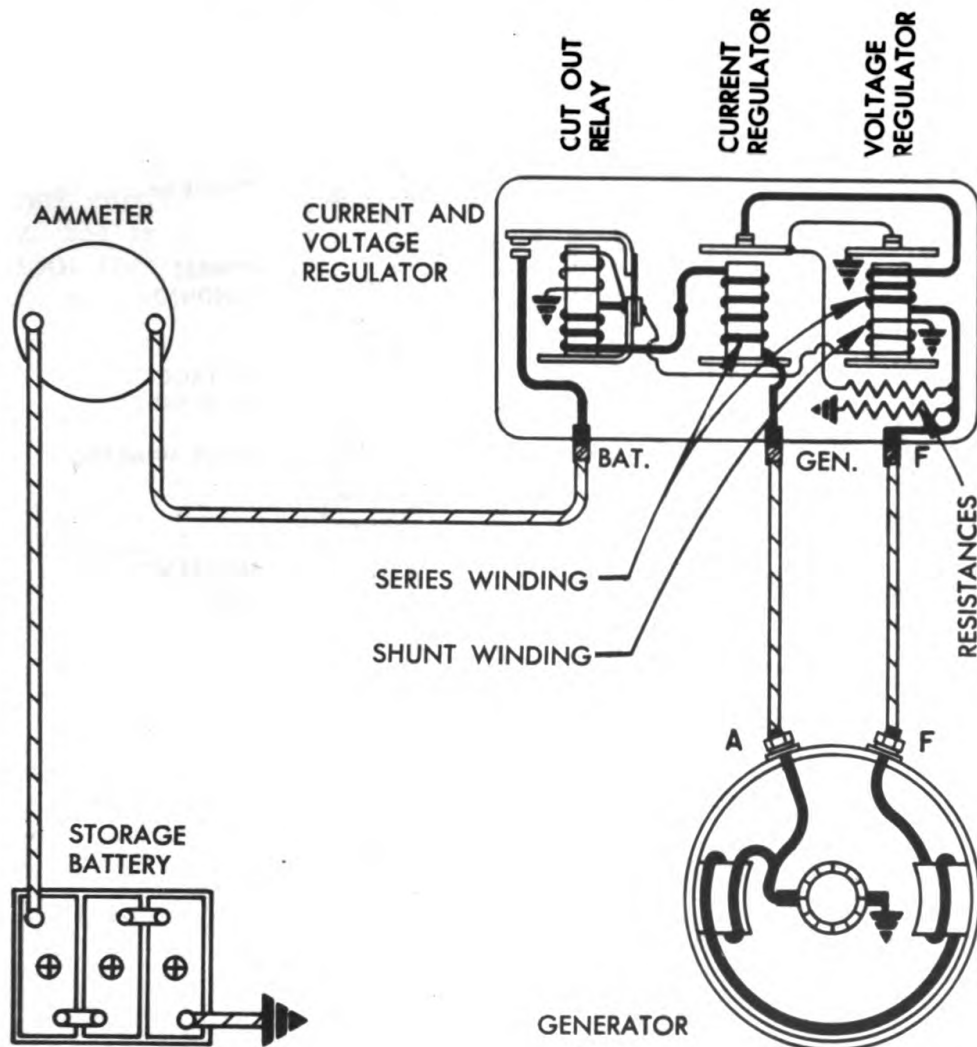
Figure 54—Schematic Wiring Circuit of Voltage Regulator

43. OPERATION OF VOLTAGE REGULATOR.

a. The voltage regulator (fig. 54) prevents the line voltage from exceeding a predetermined value, and thus protects the battery and other electrical units in the system from high voltage. One characteristic of batteries is that as either the specific gravity or charging rate increases, other conditions being the same, the battery terminal voltage increases. If the terminal voltage is held constant as the battery comes up to charge, the charging rate will gradually taper

The voltage regulator performs this job of holding the voltage

BASIC PRINCIPLES OF OPERATION



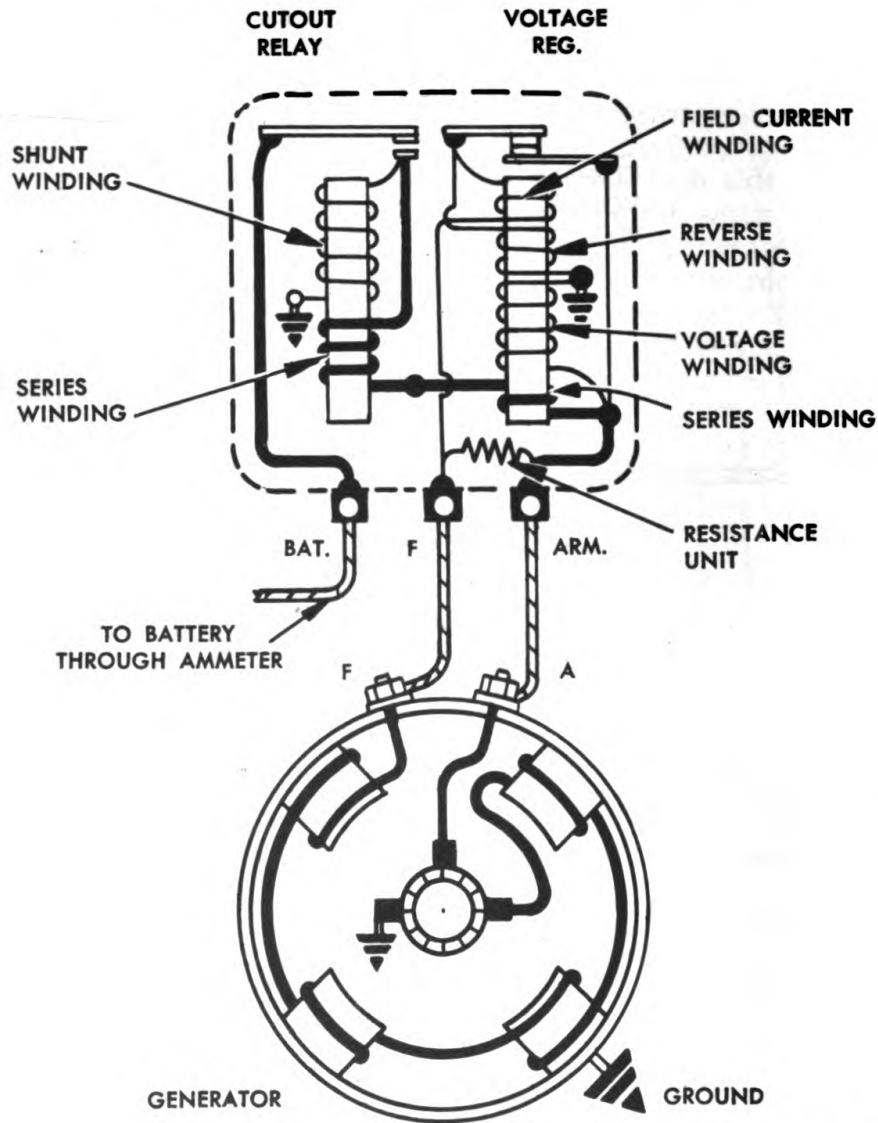
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Figure 55—Schematic Wiring Diagram of Current and Voltage Regulator

constant. The voltage regulator may be used with a third brush generator, or with a current regulator and a shunt generator.

b. The voltage regulator consists of a pair of points, one positioned on an armature, the other semistationary, and regulator windings assembled on a single core. The magnetic attraction of the windings on the armature increases as the voltage in the system increases, due to increased generator output or to the battery approaching a charged condition. The armature spring tension normally holds the regulator points closed, and the generator field current is closed through these points. With the points closed in this manner, the generator output can increase to a high value, and can cause (under the above mentioned conditions) a high voltage. When the voltage reaches a predetermined value, the magnetic attraction on the r

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RA PD 312081

Figure 56—Wiring Circuit for Voltage Regulator Used with Type Two Third-brush Generator

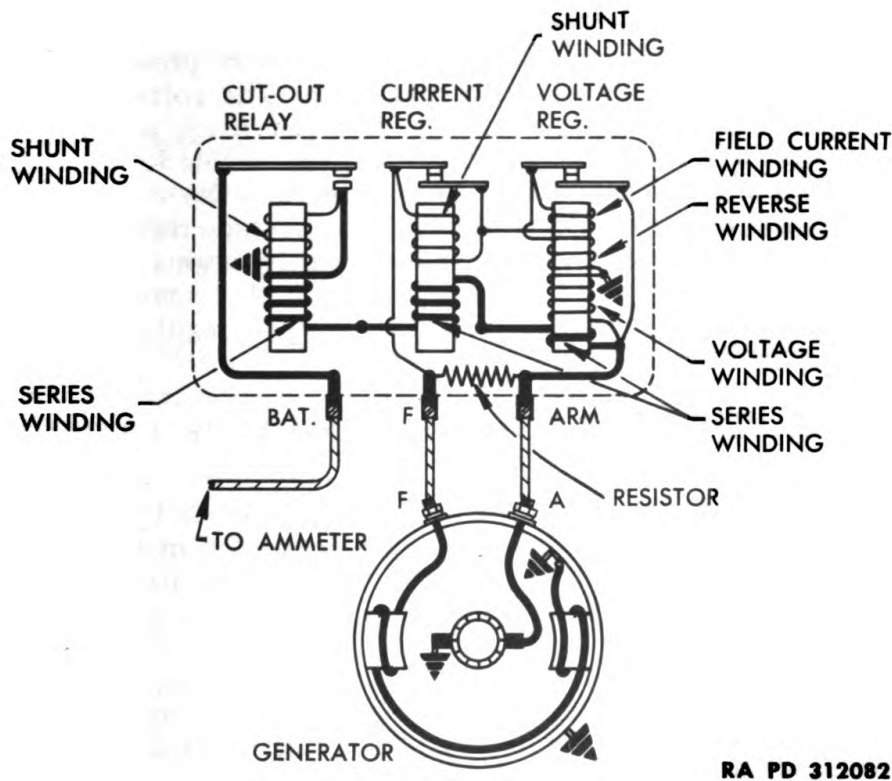
lator armature is sufficient to overcome the armature spring tension, and pull the armature toward the winding core. This opens the points, causing a resistance to be inserted into the generator field circuit. Resistance in the generator field circuit immediately causes a reduction of the generator output, with a consequent reduction of voltage. Reducing the voltage lowers the magnetic pull on the armature. Immediately, the armature is released, and the spring tension closes the regulator points. This permits an increased output and voltage, so that the points are again opened. This cycle is repeated very rapidly so that the voltage is held to a constant value, and

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the output is reduced to just what is required by the connected electrical load, and condition of charge of the battery.

44. OPERATION OF CURRENT REGULATOR.

a. Where the generator does not use a third brush to provide a means of limiting the maximum output of the generator, some external current limiting device is necessary. The current regulator (fig. 55) is a current limiting device that prevents the generator output from exceeding a safe maximum value. The current regulator is used with a voltage regulator.



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Figure 57—Wiring Circuit for Current and Voltage Regulator Used with Type Two Shunt Generator

b. The current regulator consists of a pair of points, one positioned on an armature, the other semistationary, and regulator windings assembled on a single core. As the current output of the generator reaches the value for which the current regulator is adjusted (the maximum specified output of the generator), the magnetic strength of the current regulator windings is sufficient to overcome the spring tension holding the regulator points closed. They open, and cause a resistance to be inserted into the generator field circuit. This causes a reduction of the generator output. However, as soon as the output falls below the value for which the current regulator is set, the

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magnetism becomes insufficient to hold the points open, they close, and permit the generator output to increase again. This cycle is repeated very rapidly, causing a rapid vibration of the contact points, which prevents the generator output from exceeding its specified maximum.

45. OPERATION OF CURRENT AND VOLTAGE REGULATOR.

a. When the current and voltage regulators are used together (fig. 56), either the current regulator or the voltage regulator operate at any one time. Both never operate at the same time. When the battery is low, and the load requirements are high (many accessories turned on), the current regulator operates to prevent the generator from exceeding its specified maximum. The voltage regulator does not operate because the voltage does not reach a value sufficient to cause it to operate. When the battery begins to come up to charge, and electrical accessories are turned off, the voltage begins to increase and reaches a value at which the voltage regulator begins to operate. The generator output consequently begins to taper off so that the output is below a value at which the current regulator would operate. Consequently, only the voltage regulator operates under this condition.

**46. REGULATORS FOR TYPE ONE AND TYPE TWO
GENERATORS.**

a. Paragraph 5 explained the difference between type one and type two generators. Since their fields are connected in two different ways, they require two different types of regulator circuits. Figures 54 and 55 show the regulator wiring circuits for type one generators. Step-voltage controls are used only on third brush, type one generators. Figures 56 and 57 show the regulator wiring circuits for type two generators. Type two generators usually are of heavier construction and produce higher output. Their fields are thus more highly inductive and additional windings are required in the regulator (figs. 56 and 57) to provide adequate control of the output under all operating conditions. Voltage regulators used with type one generators are all set on closed circuit with several amperes flowing from the generator to the battery. Voltage regulators used with type two generators are all checked and adjusted on open circuit, with the circuit to the battery disconnected.

CHAPTER 3
REGULATORS (Cont'd)

Section II

GROUP I—STEP-VOLTAGE CONTROLS

	Paragraph
Description	47
Cleaning, inspection, and test	48
Disassembly	49
Cleaning, inspection, and test of parts	50
Repair of parts	51
Assembly	52
Tests and adjustments	53
Specifications	54

47. DESCRIPTION.

a. The step-voltage control (fig. 58) consists of the step-voltage control unit and a cut-out relay, both mounted on the same base and enclosed by the same cover as those provided for use with third-brush, type one generators.

48. CLEANING, INSPECTION, AND TEST.

a. Clean by wiping off excess dirt with a clean cloth. Do not wash, steam, or dip-clean.

b. Remove cover and inspect for burned contact points, resistance, windings, or leads.

c. Test with unit connected to proper generator and battery.

(1) Test cut-out relay closing voltage (fig. 59) by connecting a voltmeter between the "GEN" terminal and voltage control base. Slowly increase generator speed, and note relay closing voltage.

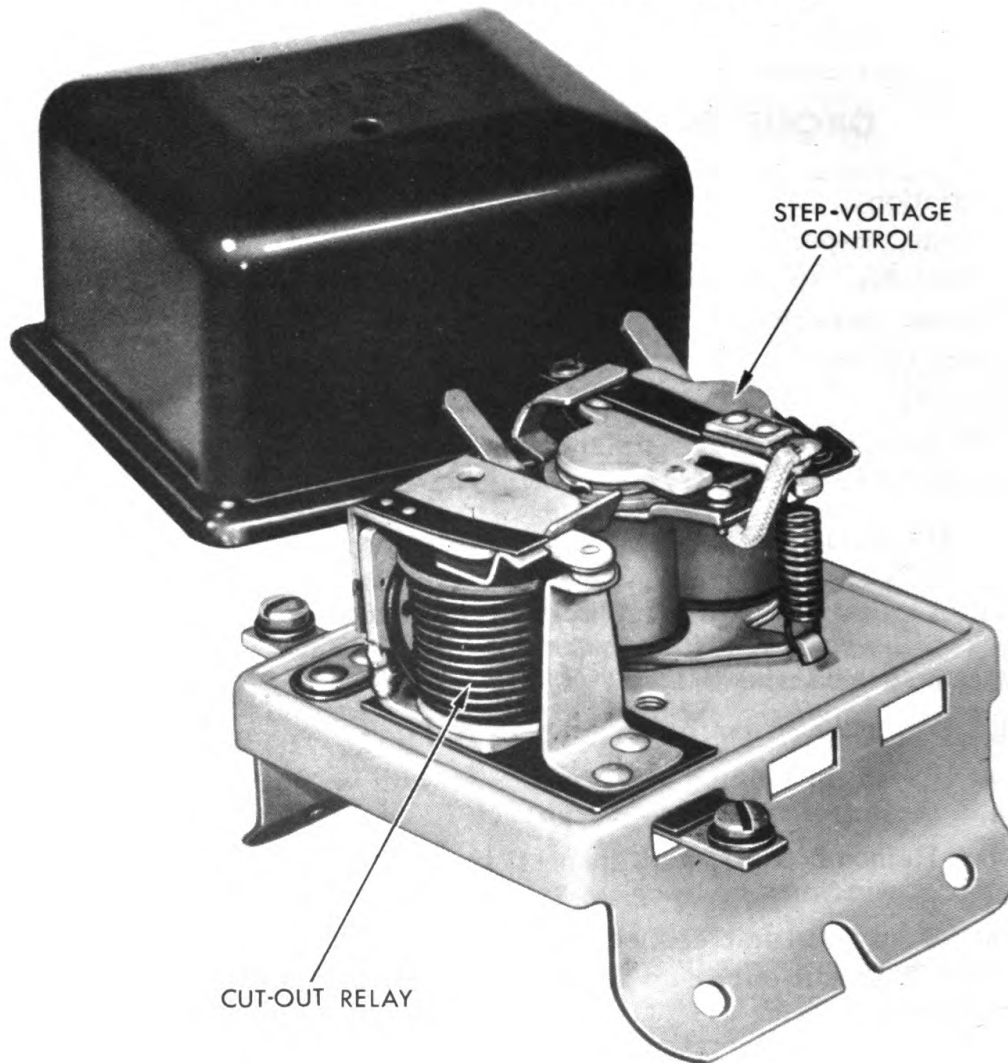
(2) Test operating voltages of step-voltage control (fig. 60) by connecting voltmeter and variable resistance, and gradually increasing generator speed until step-voltage control points open. Decrease speed, and note voltage at which points close. *NOTE: Voltage control must be at operating temperature and cover must be in place.* If battery is low, it will be necessary to cut in resistance in order to obtain sufficient voltage to cause the step-voltage control to operate and open its points. Then cut out resistance until points close.

49. DISASSEMBLY.

a. Never disassemble the step-voltage control unless some part requires replacement. The electrical and mechanical adjustments require great precision. Promiscuous disassembly and assembly not only make it necessary to reset the unit, but also damage the unit by the consequent flexing of wires, battering of windings, etc. Actually, only a few parts can be removed (fig. 61).

b. Remove cover.

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Figure 58—Step-voltage Control with Cover Removed

- c. Remove resistance.
- d. Detach voltage control armature by removing spring, two screws, lock washers, and washers. Unsolder lead.
- e. Remove cut-out relay armature by removing two screws, lock washers, and flat two-hole washer.

50. CLEANING, INSPECTION, AND TEST OF PARTS.

- a. Examine all parts. Dirty, burned, or oxidized contact points must be cleaned (par. 51). The point and fiber bumper on the flat spring on the step-voltage control armature must be tight. Leads, insulators, screws, washers must all be in good condition. If the windings, stationary cut-out relay contact point, insulators, are

GROUP I—STEP-VOLTAGE CONTROLS

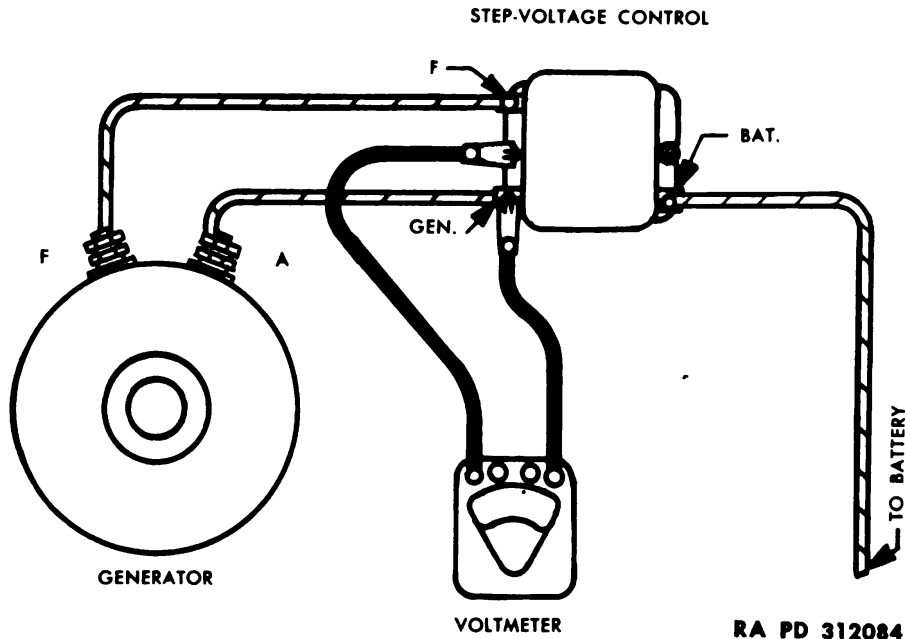


Figure 59—Meter Connections to Check Cut-out Relay Closing Voltage

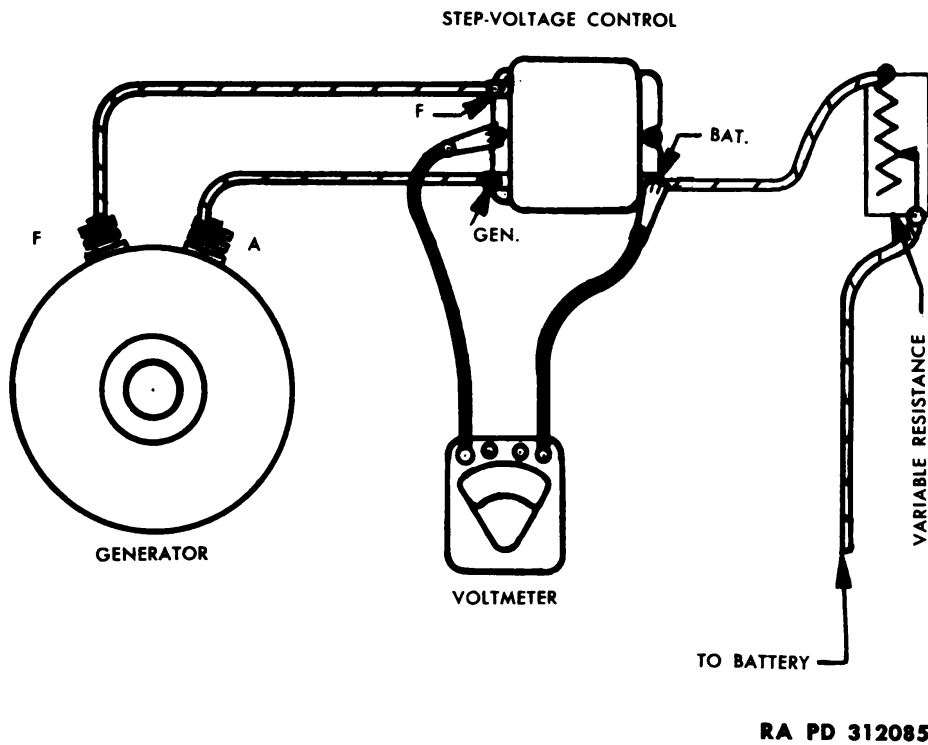
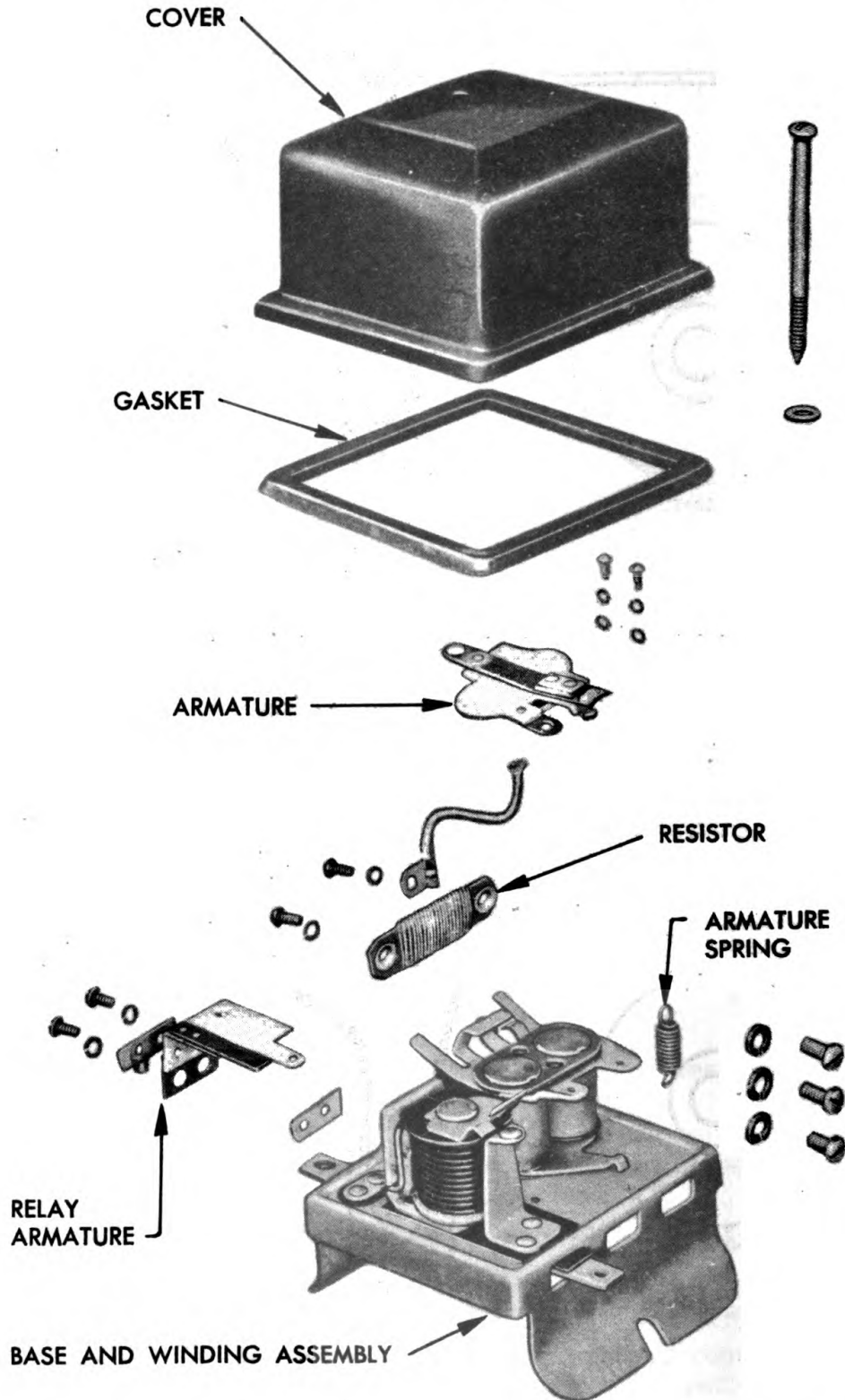


Figure 60—Meter Connections to Test Step-voltage Control

TM 9-1825A
50

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RA PD 312129

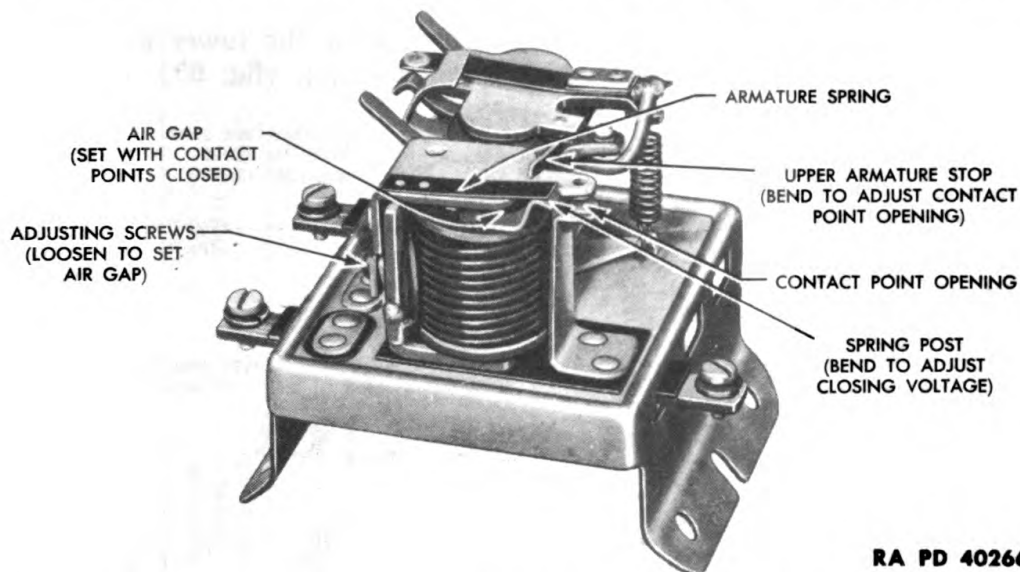
Figure 61—Step-voltage Control, Disassembled

GROUP I—STEP-VOLTAGE CONTROLS

burned or otherwise defective, replace the complete step-voltage control. The voltage control is riveted construction and only the parts shown detached (fig. 61) are serviceable items.

51. REPAIR OF PARTS.

a. Clean contact points which are pitted, rough, dirty, or burned with a stroke or two of a clean, fine-cut contact file. Blow out all dust. Be careful in cleaning the voltage control unit contact points, to avoid bending or distorting the flat armature spring. The spring must hold the two points in contact with the proper spring tension. **CAUTION:** *Never use emery cloth or sandpaper to clean the points, since small particles of emery or sand embed in the point surfaces,*



RA PD 40266

Figure 62—Cut-out Relay Adjustments (Voltage Control Unit)

and prevent good contact. Do not touch the point surfaces after cleaning them, since any trace of oil or grease causes the points to burn.

52. ASSEMBLY.

a. Attach cut-out relay armature (thick two-hole washer goes under relay armature while thin two-hole clip washer goes over armature), voltage control armature, resistance and lead.

53. TESTS AND ADJUSTMENTS.

a. Tests and adjustments are divided into two parts, mechanical and electrical. Refer to paragraph 48 c for explanation of electrical tests. Mechanical tests are outlined in following subparagraphs.

b. **Cut-out Relay.** Proceed as follows with unit disconnected:

- (1) Measure air gap between armature and center of core with contact points held closed (fig. 62), and adjust by loosening the two screws at back of relay and raising or lowering armature as required (fig. 62). Tighten screws after adjustment.

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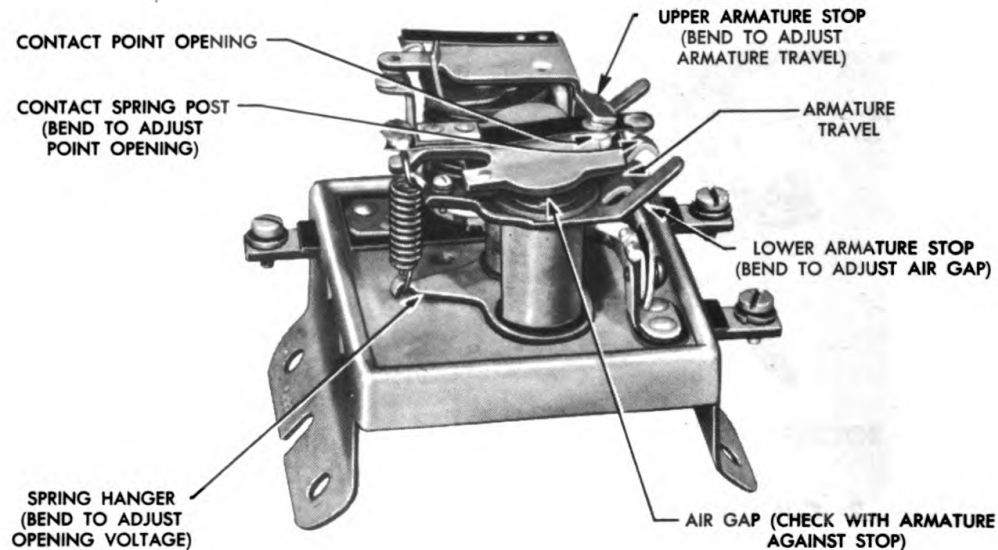
(2) Measure point opening with points open (fig. 62), and adjust by bending the upper armature stop.

(3) Check closing voltage as already described (par. 48 e (1)), and adjust by bending up on the spring post to increase the closing voltage or down to lower the closing voltage (fig. 62).

c. Step-voltage Control. Proceed as follows with unit disconnected.

(1) Measure the flat contact spring tension at the contacts with the armature up (fig. 63). Measure the pull required to separate the points. Adjust by bending the flat spring.

(2) Measure air gap between the center of the core and the armature with the armature held down against the lower armature stop. Adjust by bending the lower armature stop (fig. 63).



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Figure 63—Step-voltage Control Adjustments (Voltage Control Unit)

(3) Measure armature travel between the armature and the lower armature stop with the armature moved up against the upper armature stop. Adjust by bending the upper armature stop (fig. 63).

(4) Measure point opening with the armature held down against lower armature stop. Adjust by bending contact spring post (fig. 63).

(5) Adjust opening voltage by bending the lower spring hanger down to increase the opening voltage, or up to lower the opening voltage (fig. 63).

(6) Check closing voltage (par. 48 e (2)) and adjust by increasing the air gap to raise the closing voltage and decreasing the air gap to lower the closing voltage. Only a slight air gap adjustment will normally be required. After this adjustment, readjust the contact point opening to bring it back to the proper limits, if necessary.

GROUP 1—STEP-VOLTAGE CONTROLS

54. SPECIFICATIONS.

a. Group I Regulators—Step-voltage Controls.

VOLTAGE CONTROL UNIT

Model	Air Gap (inches)	Point Opening (inches)	Contact Spring Tension (oz)	Armature Travel (inches)	Points Open (Volts)		Points Close (Volts)	
					70°F	180°F	70°F	180°F
5540	0.035	0.010	0.7-0.9	0.035	8.3-8.7	7.75-8.2	7.25-7.75	6.55-7.1
5586	0.035	0.010	0.5-1.1	0.030	15.4-16.35	14.4-15.35	13.9-15.1	12.8-14.1
5830	0.035	0.010	0.7-0.9	0.035	8.3-8.7	7.75-8.2*	7.25-7.75	6.55-7.1*
5833	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5834	0.035	0.010	0.5-1.1	0.030	15.4-16.35	14.4-15.35	13.9-15.1	12.8-14.1
5838	0.035	0.010	0.5-1.1	0.030	15.4-16.35	14.4-15.35	13.9-15.1	12.8-14.1
5839	0.035	0.010	0.7-0.9	0.035	8.3-8.7	7.75-8.2*	7.25-7.75	6.55-7.1*
5849	0.045	0.015	0.7-1.4	0.045	14.1-14.7	14.1-14.7	12.0 max.	12.0 max.
5850	0.035	0.010	0.7-0.9	0.035	8.3-8.7	7.75-8.2	7.25-7.75	6.55-7.1
5851	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5859	0.015	0.022	0.7-0.9	0.060	28.5-31.5	26.5-28.5	15.0 max.	15.0 max.
5863	0.045	0.015	0.7-1.4	0.045	7.65-8.05	7.55-7.95	6.65-7.15	6.35-6.95
5868	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5869	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.
5882	0.030	0.010	0.5-1.1	0.030	14.6-15.55	13.6-14.55	13.3-14.5	12.2-13.5
5883	0.035	0.010	0.5-1.1	0.035	7.9-8.3	7.35-7.8	6.95-7.45	6.25-6.8*
5884	0.035	0.010	0.5-1.1	0.030	15.4-16.35	14.4-15.35	13.9-15.1	12.8-14.1
5886	0.035	0.010	0.5-1.1	0.030	14.5-15.2	13.5-14.2	12.5-13.2	11.5-12.2
5887	0.015	0.022	0.7-0.9	0.060	28.5-31.5	26.5-28.5	15.0 max.	15.0 max.
5888	0.045	0.015	0.7-1.4	0.045	14.1-14.7	14.1-14.7	12.0 max.	12.0 max.
5889	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5890	0.045	0.015	0.7-1.4	0.045	7.65-8.05	7.55-7.95	6.65-7.15	6.35-6.95
5891	0.035	0.010	0.5-1.1	0.030	14.5-15.2	13.5-14.2	12.5-13.2	11.5-12.2
5892	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5893	0.035	0.010	0.5-1.1	0.035	7.45-7.85	6.95-7.35*	6.0 max.	6.0 max.*
5897	0.045	0.015	0.7-1.4	0.045	14.1-14.7	14.1-14.7	12.0 max.	12.0 max.

*Voltage at 150° F.

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CUT-OUT RELAY

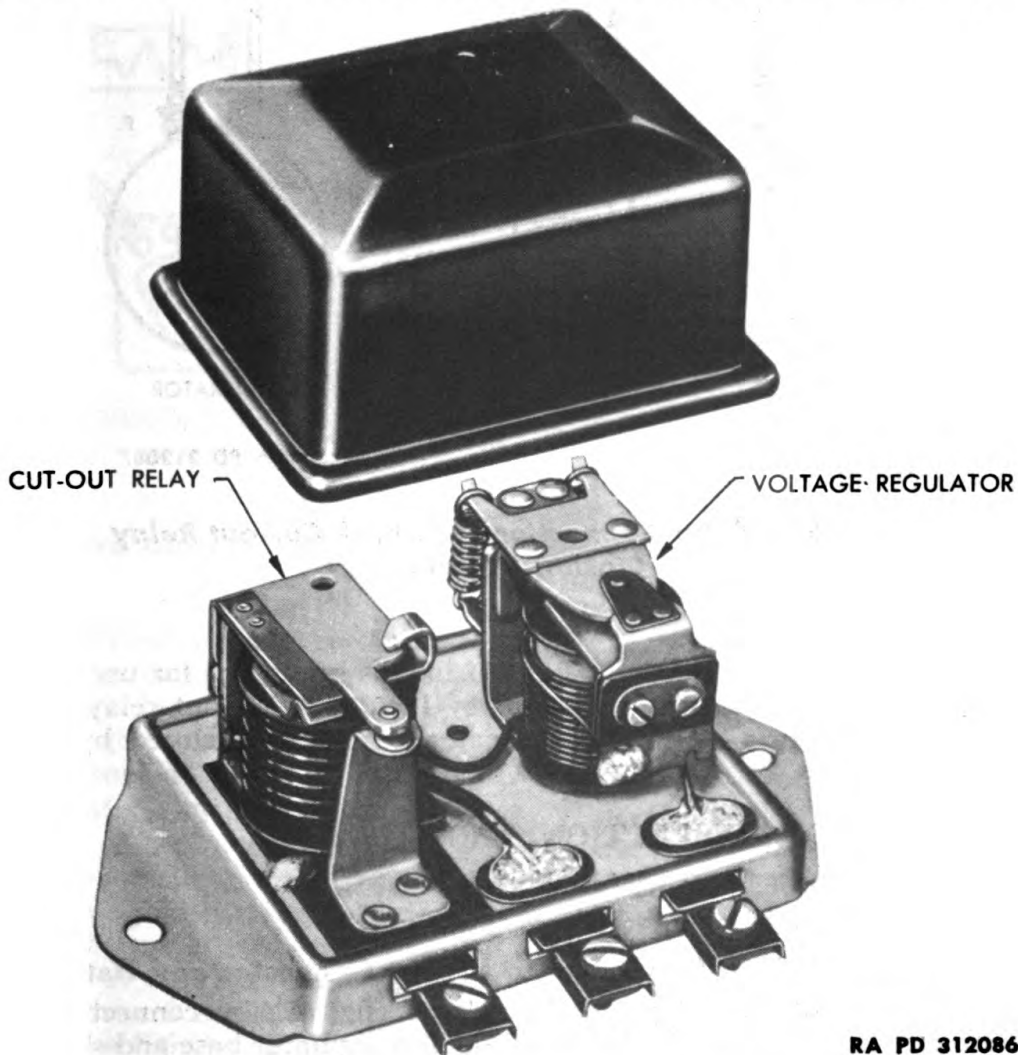
Model	Air Gap (Inches)	Point Opening (Inches)	Points Close (Volts) 70° F	Points Open (Amps Reverse Current)
5540	0.015	0.020	6.3-6.9	0-3.0
5586	0.015	0.020	13.0-14.2	0-4.0
5830	0.020	0.020	6.3-6.9	0-3.0
5833	0.015	0.020	6.3-6.9	0-4.0
5834	0.015	0.020	13.0-14.2	0-4.0
5838	0.015	0.020	13.0-14.2	0-4.0
5839	0.020	0.020	6.3-6.9	0-3.0
5849	0.015	0.020	12.9-13.9	0-4.0
5850	0.015	0.020	6.3-6.9	0-3.0
5851	0.015	0.020	6.3-6.9	0-4.0
5859	0.020	0.030	24.5-27.5	3.0 max.
5863	0.015	0.020	6.3-6.9	0-4.0
5868	0.015	0.020	6.3-6.9	0-4.0
5869	0.015	0.020	6.3-6.9	0-4.0
5882	0.020	0.020	12.4-13.6	4.0 max.
5883	0.020	0.020	6.0-6.6	3.0 max.
5884	0.015	0.020	13.0-14.2	0-4.0
5886	0.020	0.020	13.2-14.0	0-4.0
5887	0.020	0.030	24.5-27.5	3.0 max.
5888	0.015	0.020	12.9-13.9	0-4.0
5889	0.015	0.020	6.3-6.9	0-4.0
5890	0.015	0.020	6.3-6.9	0-4.0
5891	0.020	0.020	13.2-14.0	0-4.0
5892	0.015	0.020	6.3-6.9	0-4.0
5893	0.015	0.020	6.3-6.9	0-4.0
5897	0.015	0.020	12.9-13.9	0-4.0

CHAPTER 3
REGULATORS (Cont'd)

Section III

**GROUP II—VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**

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Disassembly	57
Cleaning, inspection, and test of parts	58
Repair of parts	59
Assembly	60
Tests and adjustments	61
Specifications	62



**Figure 64—Voltage Regulator for Type One
Third-brush Generator**

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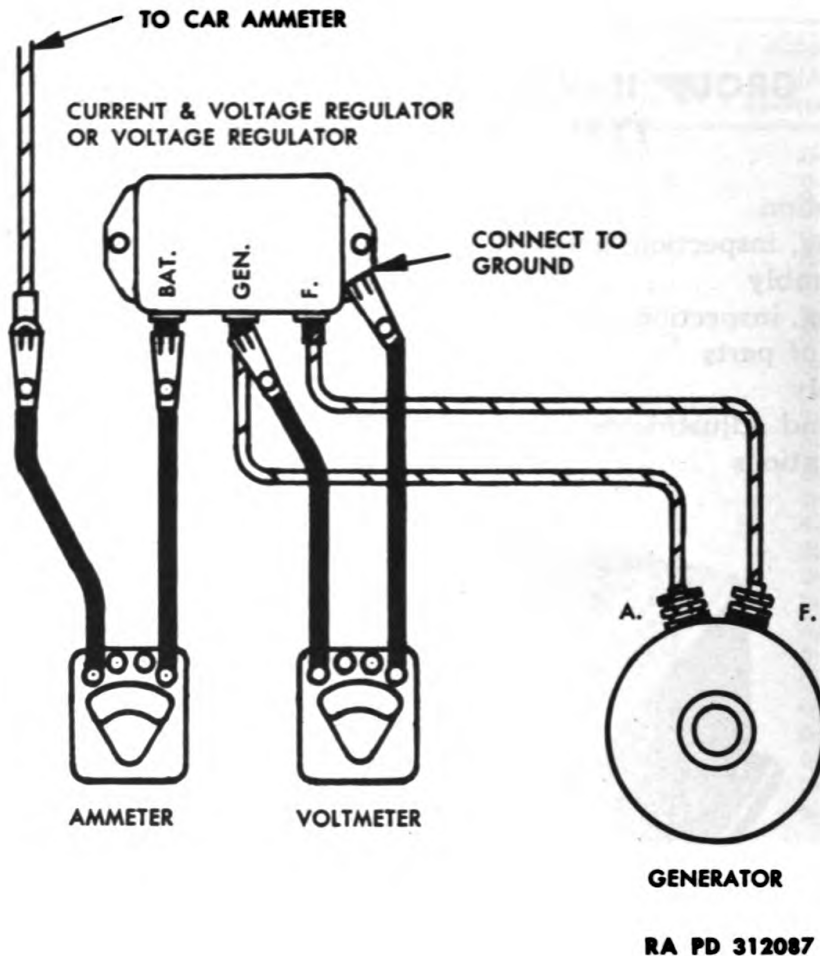


Figure 65—Meter Connections to Check Cut-out Relay Closing Voltage

55. DESCRIPTION.

a. The voltage regulators (fig. 64) in this group are for use with third-brush, type one generators. They include a cut-out relay and voltage regulator mounted on the same base, and enclosed by the same cover.

56. CLEANING, INSPECTION, AND TEST.

a. **Clean.** Refer to paragraph 48 a.

b. **Inspect.** Refer to paragraph 48 b.

c. **Test with Unit Connected to Proper Generator and Battery.**

(1) Test cut-out relay closing voltage (fig. 65) by connecting a voltmeter between the "GEN" terminal and regulator base and slowly increasing generator speed until points close.

(2) Test voltage regulator setting by either of two methods, the fixed resistance, or the variable resistance method.

GROUP II—VOLTAGE REGULATORS FOR TYPE ONE GENERATORS

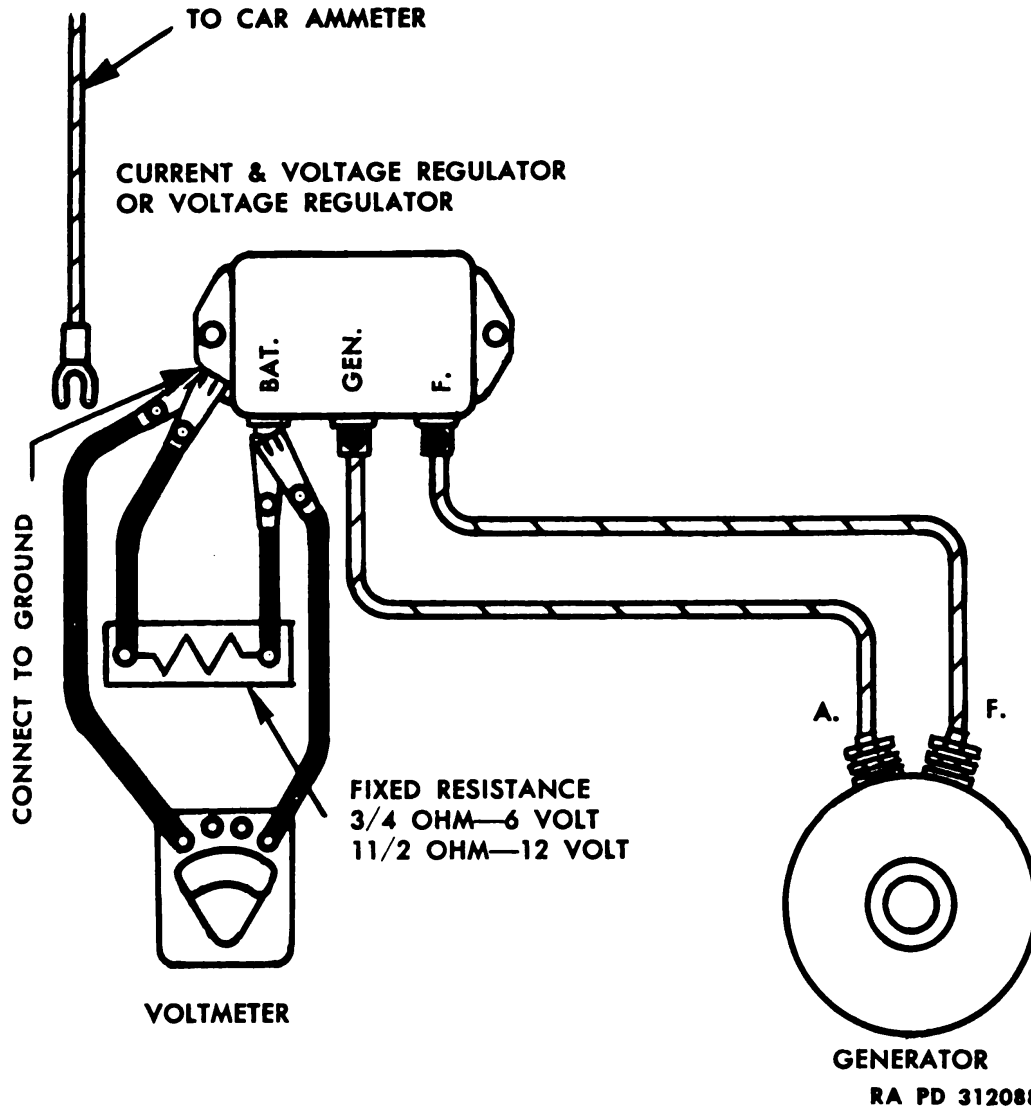


Figure 66—Fixed Resistance Method of Checking Voltage Regulator Setting

(a) *Fixed Resistance Method.* Disconnect lead from regulator "BAT" terminal and connect $\frac{3}{4}$ ohm resistance ($1\frac{1}{2}$ ohms for 12-volt regulator) between "BAT" terminal and regulator base (fig. 66). Operate generator at medium speed, and with regulator at operating temperature note voltage setting. Cover must be in place.

(b) *Variable Resistance Method.* With the variable resistance method (fig. 67), a variable $\frac{1}{4}$ ohm resistance, an ammeter, and a voltmeter must be used. Connect the ammeter and variable resistance in series with battery and regulator. Connect voltmeter from the "BAT" terminal to base of regulator. Operate generator at medium speed with regulator at operating temperature, and cover in place. If less than 8 amperes is obtained, place small load across battery (such as a light) and then cut in resistance until output drops 8 to 10 amperes. Slow generator, and bring back to speed. Note voltage setting.

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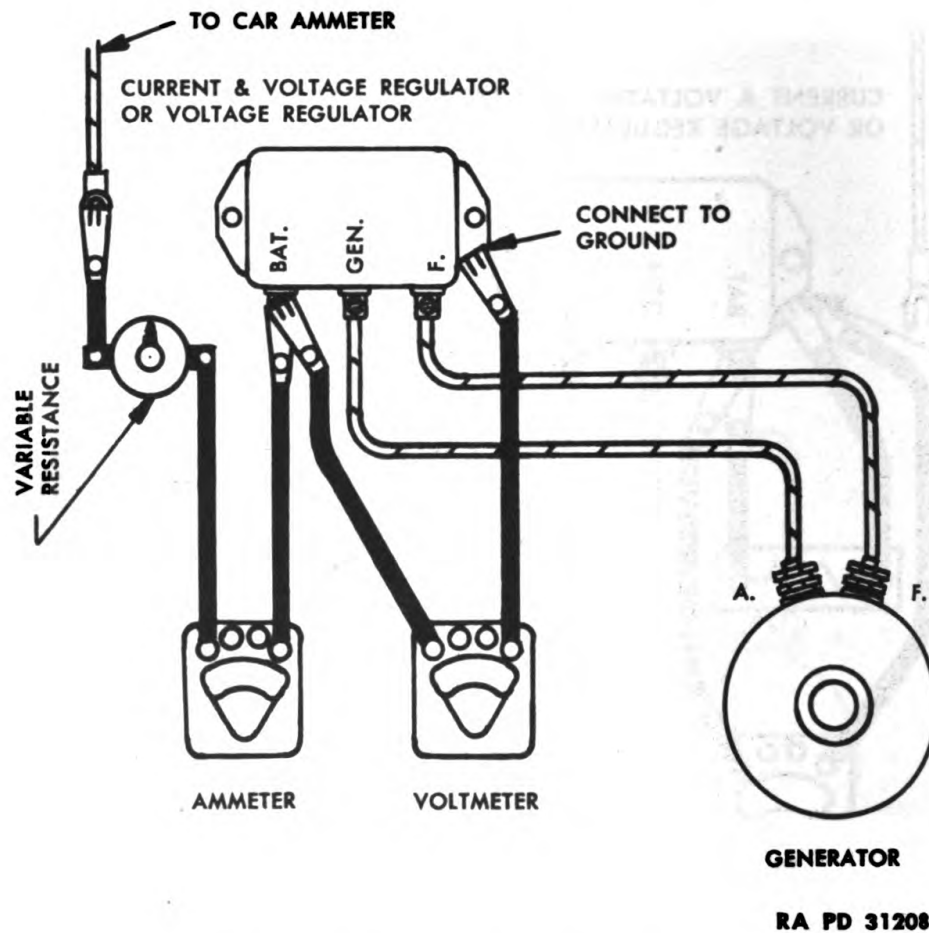
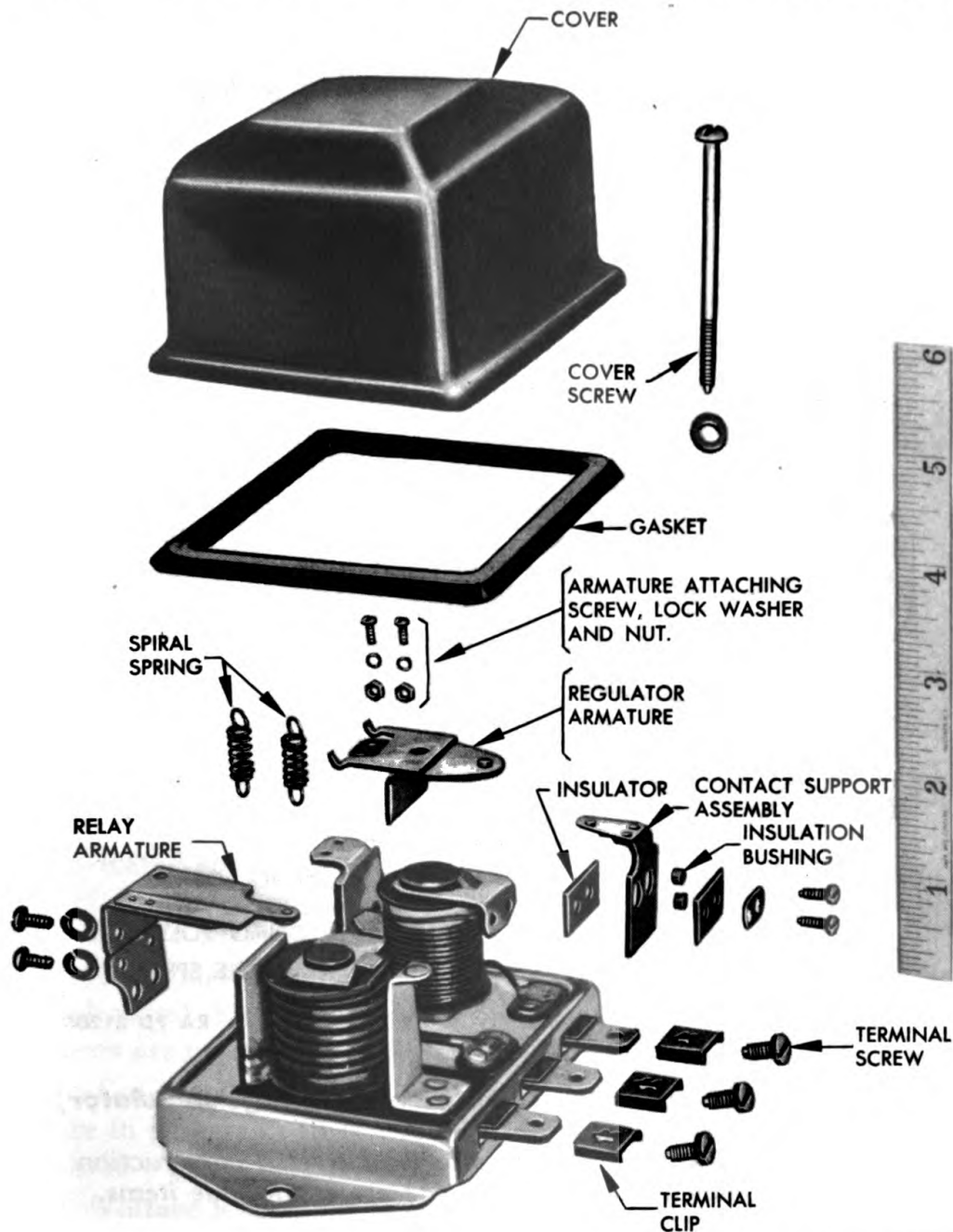


Figure 67—Variable Resistance Method of Checking Voltage Regulator Setting

57. DISASSEMBLY.

- a. Never disassemble the regulator unless some part requires replacement. Actually, only a few parts can be removed (fig. 68).
- b. Remove cover.
- c. Remove relay armature by unsoldering lead and taking out two screws.
- d. Remove regulator upper contact support by taking out two screws, lock washers, and washer.
- e. Remove voltage regulator armature by taking off two spiral springs and drilling out two rivets that mount the armature spring hinge to regulator frame. Support frame to avoid bending it, center-punch rivet heads and use $\frac{3}{32}$ drill. Remove only if armature requires replacement.

GROUP II—VOLTAGE REGULATORS FOR TYPE ONE GENERATORS



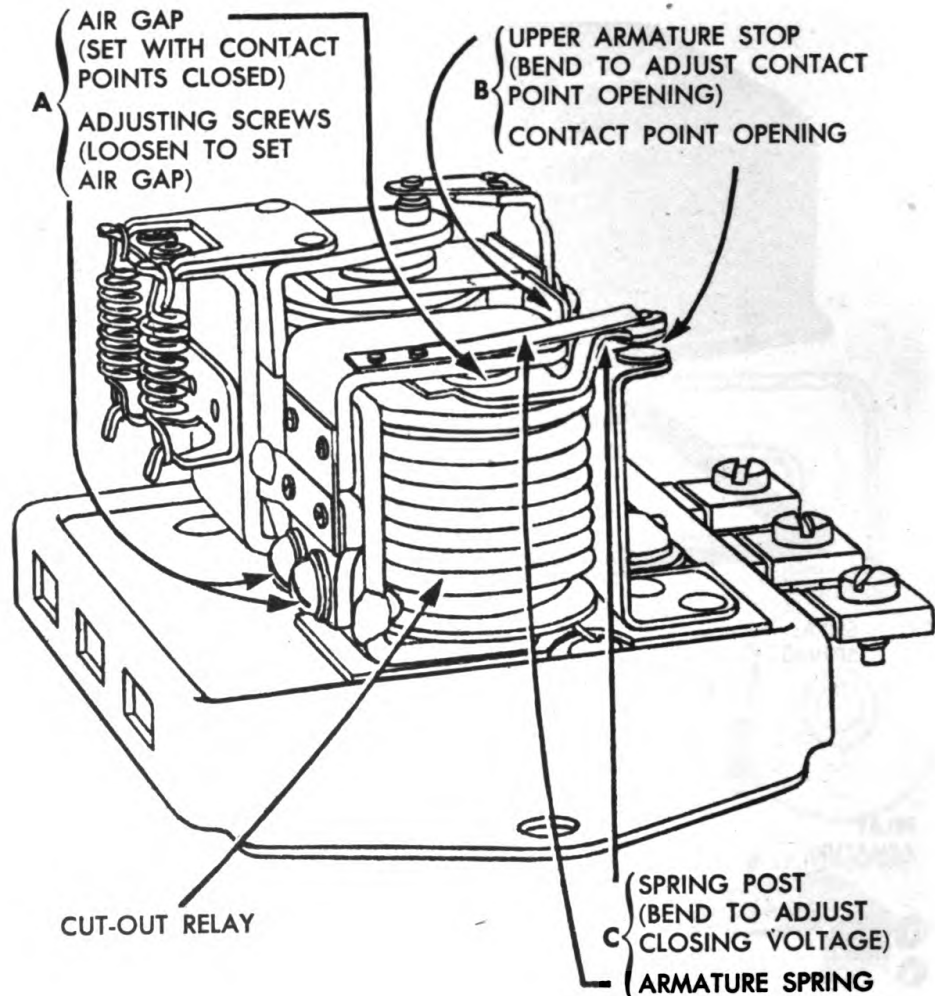
RA PD 312090

Figure 68—Voltage Regulator, Disassembled

58. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Examine all parts. Clean dirty, burned, or oxidized contact points (par. 59). Insulators, screws, washers, and leads must all be in good condition. If the windings, stationary cut-out relay contact point, or insulators, are burned or otherwise defective, replace com-

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RA PD 312091

Figure 69—Cut-out Relay Adjustments (Voltage Regulator)

plete regulator. NOTE: *The regulator is of riveted construction and only the parts shown detached (fig. 68) are serviceable items.*

59. REPAIR OF PARTS.

a. Clean pitted, rough, dirty, burned, or oxidized contact points with a clean, fine-cut contact file. It is not necessary to file away all pits. Use a riffler or spoon file to clean out any pits which might have formed on the flat point.

60. ASSEMBLY.

a. If regulator armature has been removed, install replacement armature with screws, lock washers, and nuts, furnished with replacement armature. Assemble screws down so they do not ground against cover.

GROUP II—VOLTAGE REGULATORS FOR TYPE ONE GENERATORS

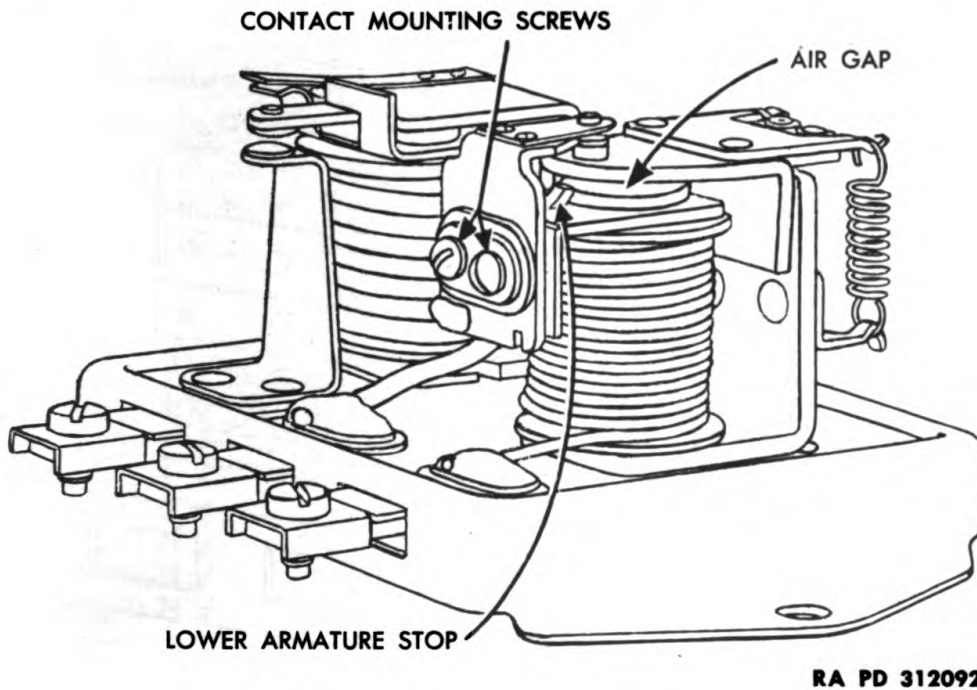


Figure 70—Voltage Regulator, Cover Removed

- b. Install regulator upper contact support.
- c. Install relay armature and resolder lead to it.
- d. Install spiral springs.

61. TESTS AND ADJUSTMENTS.

a. Tests and adjustments are divided into two parts, mechanical and electrical. Electrical tests are outlined in paragraph 56, mechanical tests are outlined below.

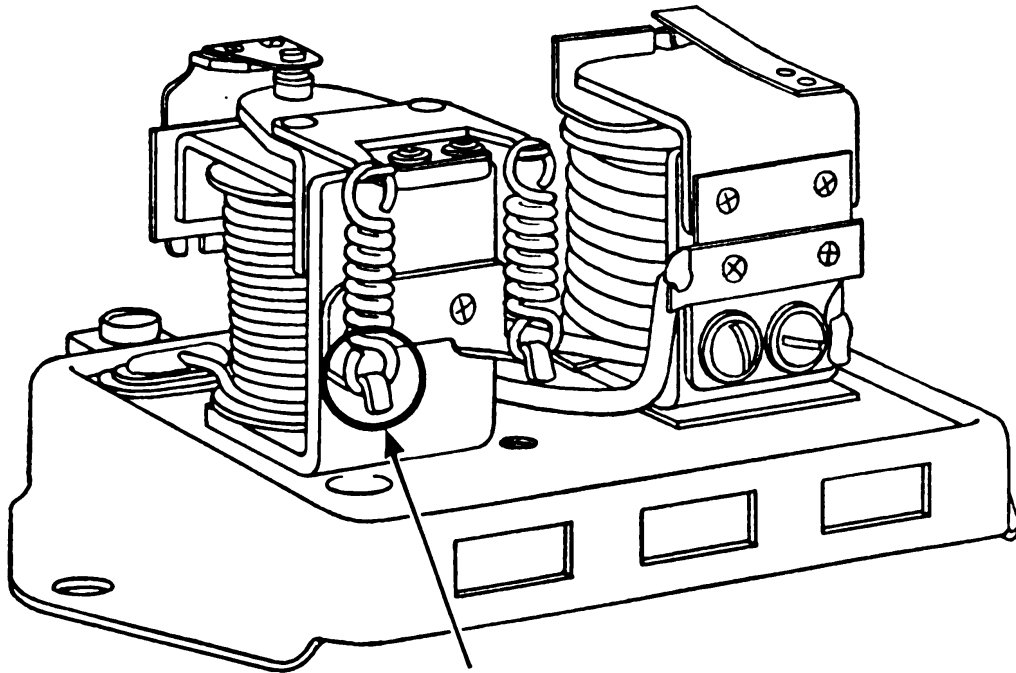
b. **Cut-out Relay.** With unit disconnected (fig. 69), follow procedure in paragraph 53 b. Check closing voltage as outlined in paragraph 56 c (1).

c. **Voltage Regulator.** With unit disconnected, proceed as follows:

(1) Measure air gap with points just touching, between the center of the winding core and the armature (fig. 70). Push armature all way down by hand, release until the points come together and then measure the air gap. Adjust by loosening the two upper contact mounting screws, and raising or lowering the upper contact support as required. Tighten screws after adjustment.

(2) Check voltage regulator setting as already detailed (par. 56 c (2)) and adjust (regardless of which method of test is used) by bending the spring hanger of one spiral spring down to increase the

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ELECTRICAL EQUIPMENT (DELCO-REMY)**



VOLTAGE REGULATOR UNIT LOWER SPRING HANGER
BEND DOWN TO INCREASE VOLTAGE SETTING, BEND UP TO DECREASE VOLTAGE
SETTING.

MAKE ADJUSTMENT ON ONE SPRING
CHANGE TENSION ON BOTH SPRINGS ONLY WHEN ADJUSTMENT OF ONE SPRING
WILL NOT BRING SETTING WITHIN SPECIFICATIONS.

RA PD 312093

Figure 71—Voltage Setting Adjustment

voltage setting, or bend up to lower it (fig. 71). After each change of voltage setting, replace regulator cover, reduce generator speed until relay points open, then bring back to speed again and note voltage setting. In addition, if the voltage is being checked by the variable resistance method, readjust the variable resistance when required to bring the current output back within the 8 to 10 ampere range. *NOTE: If spiral springs have been removed, replace one and connect voltmeter from the "GEN" terminal of regulator to base.* Open the voltage regulator points by hand, and slowly increase speed until 3 volts (6 volts on 12-volt unit) is obtained. This establishes the approximate speed at which the first spring is adjusted. Hold generator speed at this value, release points, and adjust setting to $\frac{1}{2}$ total specified setting. Install second spring, connect meters (par. 56) (either method) and complete adjustment on this spring alone, as already outlined.

GROUP II—VOLTAGE REGULATORS FOR TYPE ONE GENERATORS
62. SPECIFICATIONS.

a. Group II Regulators—Voltage Regulator Used with Type One Generators.

Voltage Regulator Air Gap..... 0.070 inch
Cut-out Relay Air Gap..... 0.020 inch
Cut-out Relay Point Opening..... 0.020 inch

Model	Current Regulator Current Setting (Amps) Hot †	Voltage Regulator Voltage Setting (Closed Circuit)* Hot †	Cut-out Relay Points Close (Volts) Hot †
1118203 N #	—	7.2– 7.4	6.2– 6.7
1118204 P #	—	7.2– 7.4	6.2– 6.7
1118227 P #	—	14.0–14.2	12.4–13.4
1118228 N #	—	14.0–14.2	12.4–13.4
1118243 N #	—	7.2– 7.4	6.2– 6.7
1118247 N #	—	14.0–14.2	12.4–13.4
1118250 N #	—	14.0–14.2	12.4–13.4

*Operate generator at the speed at which it will produce rated output and adjust current to 8 to 10 amps.

†Hot—Operating temperature.

*** CAUTION:** *These regulators are designed for operation with a particular polarity system. Using a regulator which is designed for operation on a positive grounded system with a battery which has the negative terminal grounded, will quickly destroy the regulator.*

N—Negative.

P—Positive.

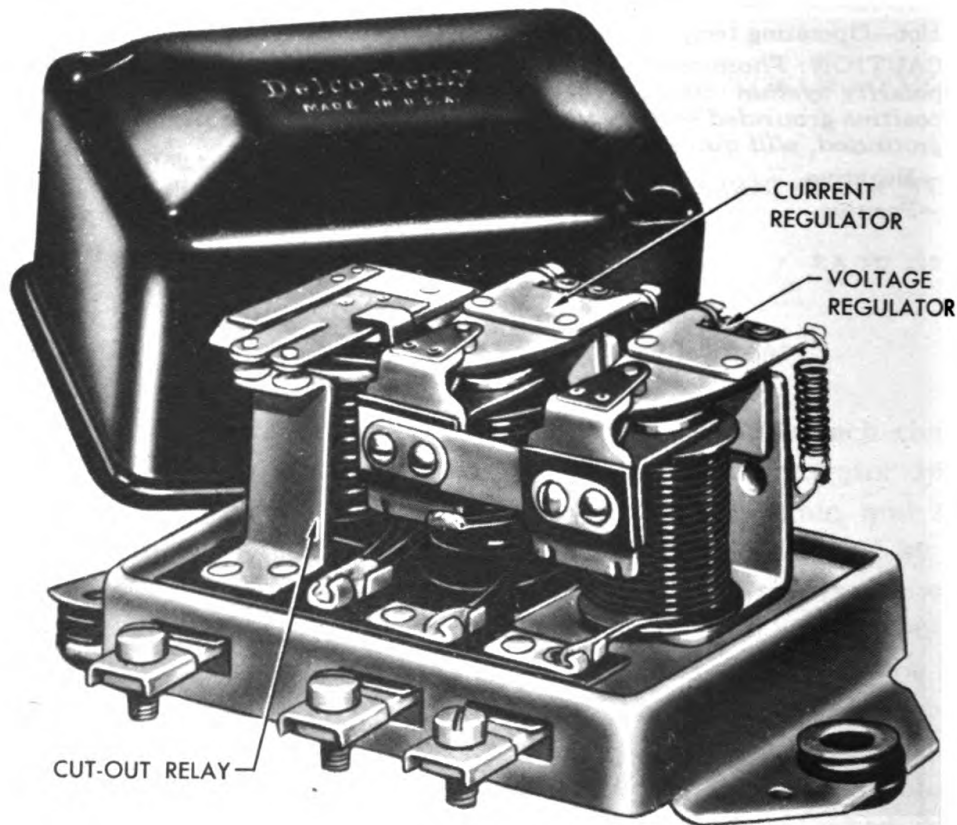
ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 3
REGULATORS (Cont'd)

Section IV

GROUP III—CURRENT AND VOLTAGE REGULATORS
FOR TYPE ONE GENERATORS

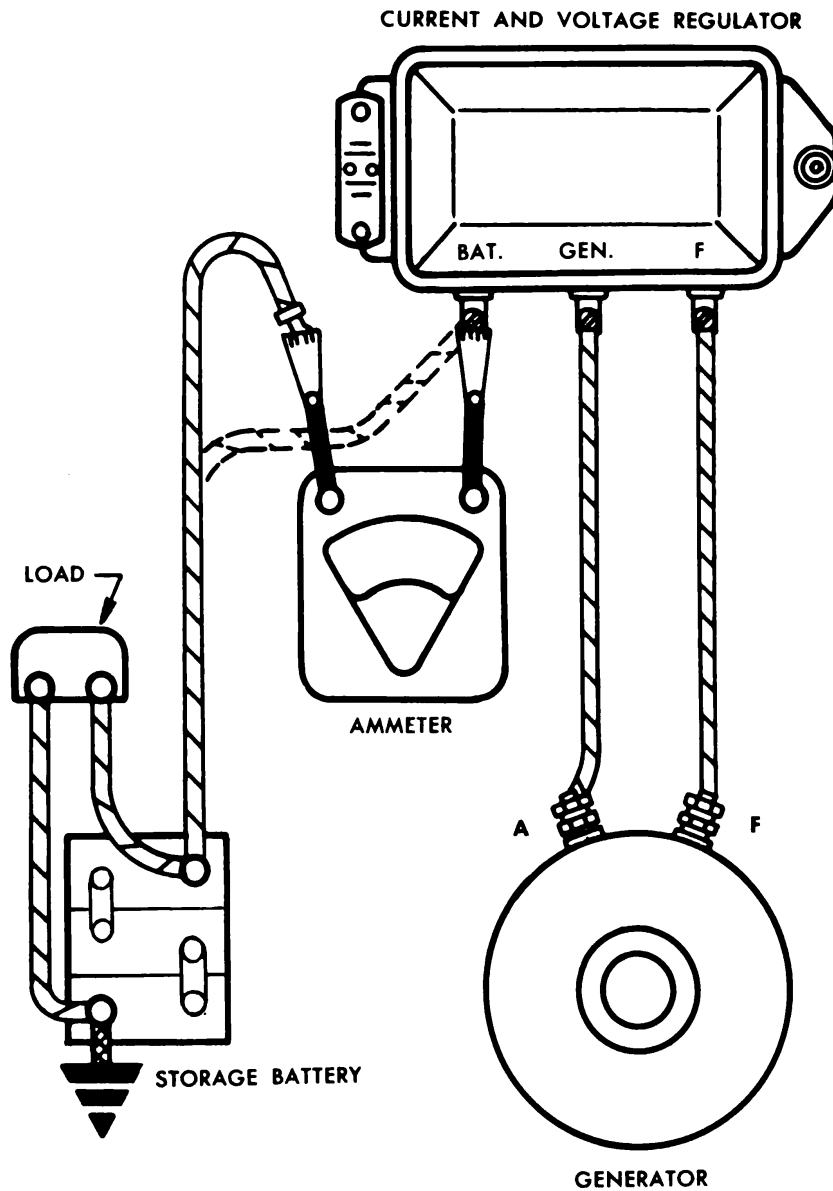
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Figure 72—Current and Voltage Regulator for Type One Shunt Generator

**GROUP III—CURRENT AND VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**



RA PD 312095

Figure 73—Load Method of Checking Current Regulator Setting

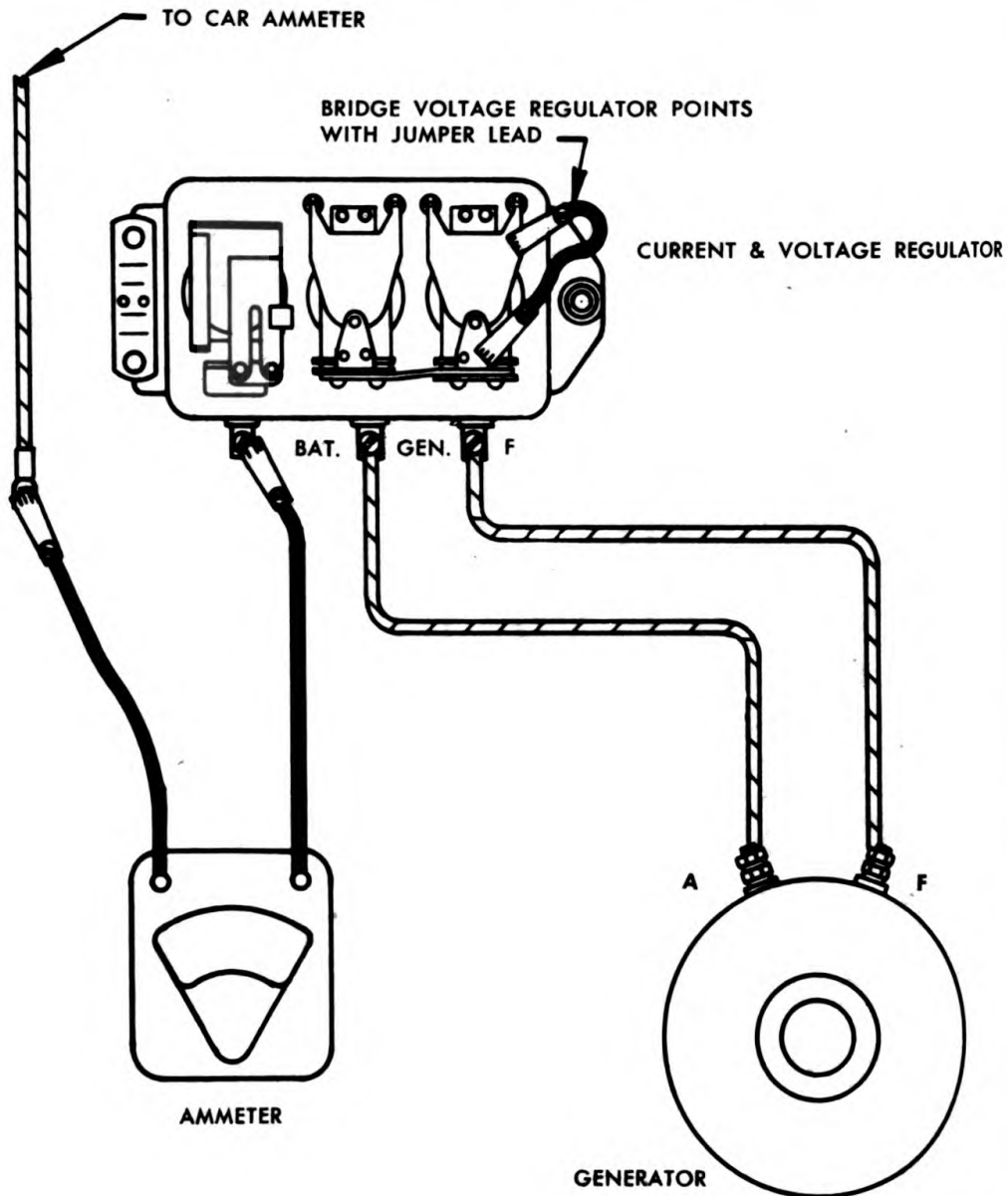
63. DESCRIPTION.

a. The current and voltage regulators (fig. 72) in this group are for use with shunt, type one generators. They include a cut-out relay, a voltage regulator, and a current regulator, all mounted on the same base and enclosed by the same cover.

64. CLEANING, INSPECTION, AND TEST.

- a. Clean. Refer to paragraph 48 a.
- b. Inspect. Refer to paragraph 48 b.

**ORDNANCE MAINTENANCE
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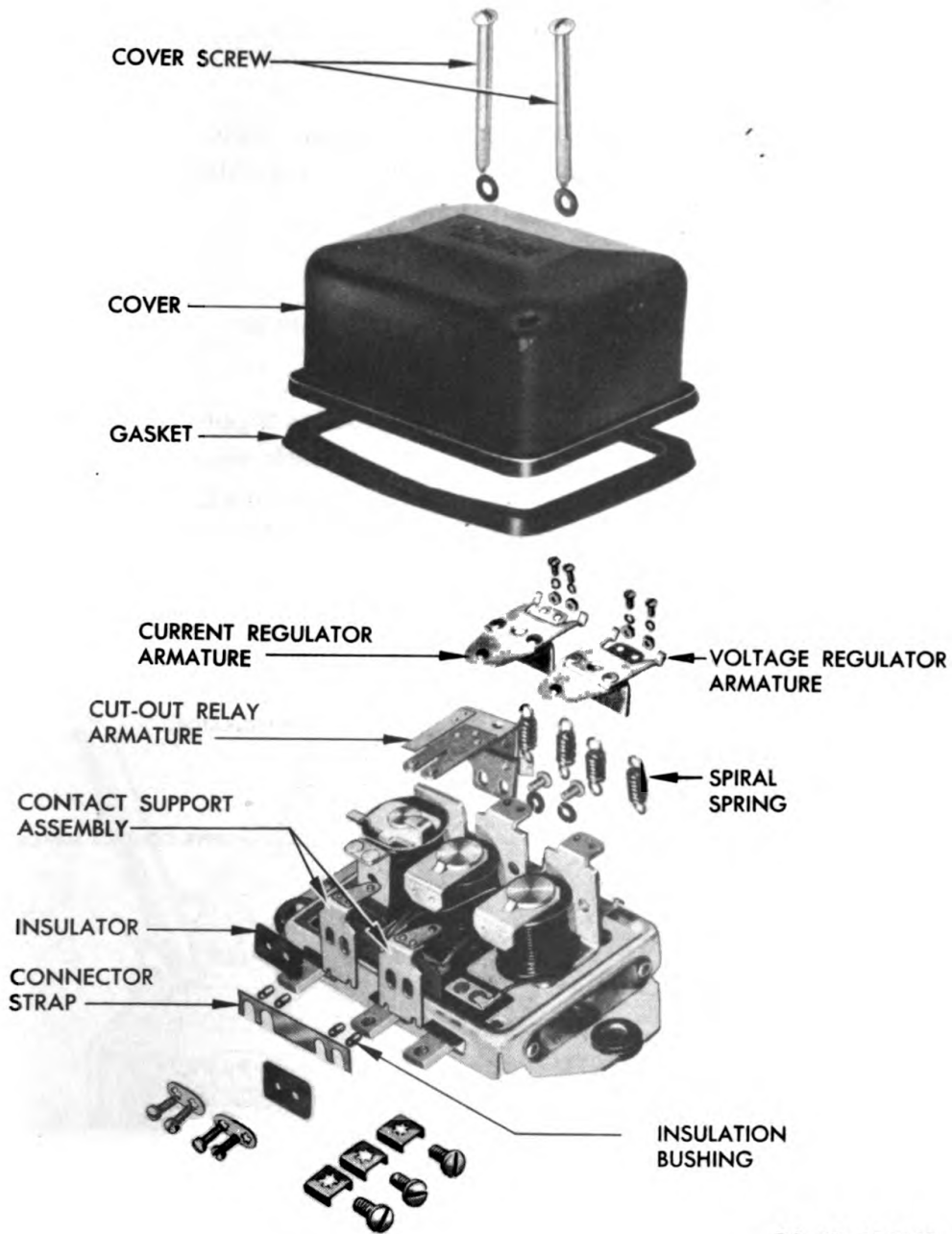


RA PD 312096

Figure 74—Jumper Lead Method of Checking Current Regulator Setting

- c. **Test With Unit Connected to Proper Generator and Battery.**
- (1) **TEST CUT-OUT RELAY** (par. 56 c (1)).
 - (2) **TEST VOLTAGE REGULATOR SETTING** (par. 56 c (2)).
 - (3) Test current regulator by either of two following methods, either of which prevents voltage regulator from operating:
 - (a) **Load Method.** Place a load approximating current regulator setting across battery, connect ammeter into circuit at regulator

**GROUP III—CURRENT AND VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**



RA PD 312097

Figure 75—Current and Voltage Regulator, Disassembled

“BAT” terminal (fig. 73), operate generator at medium speed, and note current regulator setting.

(b) *Jumper Lead Method.* Place a jumper lead across voltage regulator contact points, connect ammeter into circuit at regulator

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

“BAT” terminal (fig. 74), operate generator at medium speed and note current regulator setting.

65. DISASSEMBLY.

a. Never disassemble the regulator unless some part requires replacement. This disturbs the electrical and mechanical settings and makes it necessary to completely reset unit.

b. Remove cover.

c. Remove relay armature by unsoldering lead and taking out two screws and lock washers.

d. Remove current regulator upper contact support by unsoldering lead and removing two screws, two-hole lock washers, two-hole insulators, two small bushings, upper contact support, and two-hole insulator. The connector strap may be left in place if only one of the upper contact supports is removed.

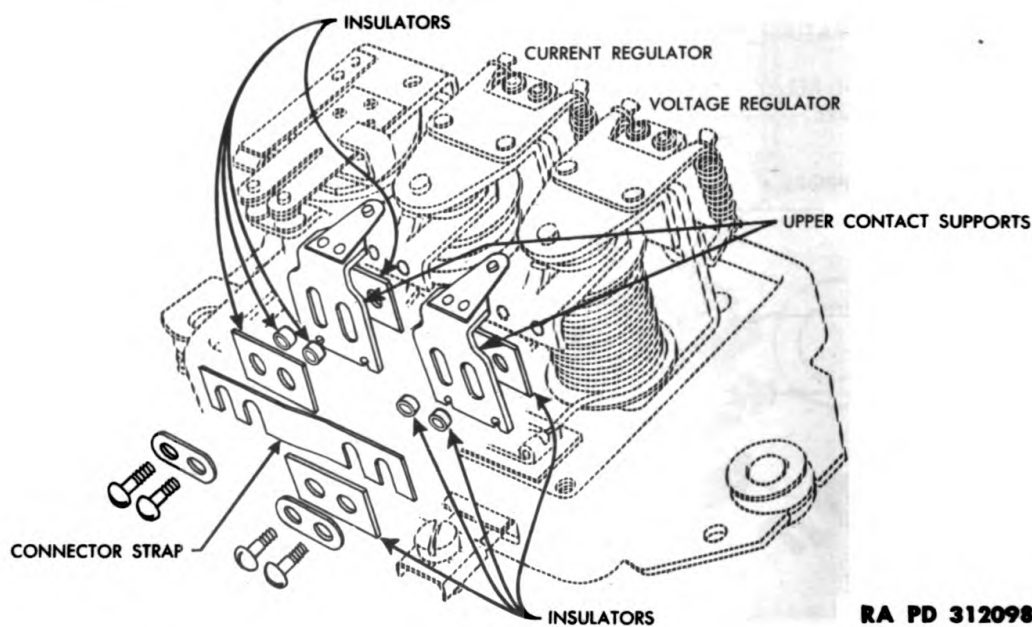
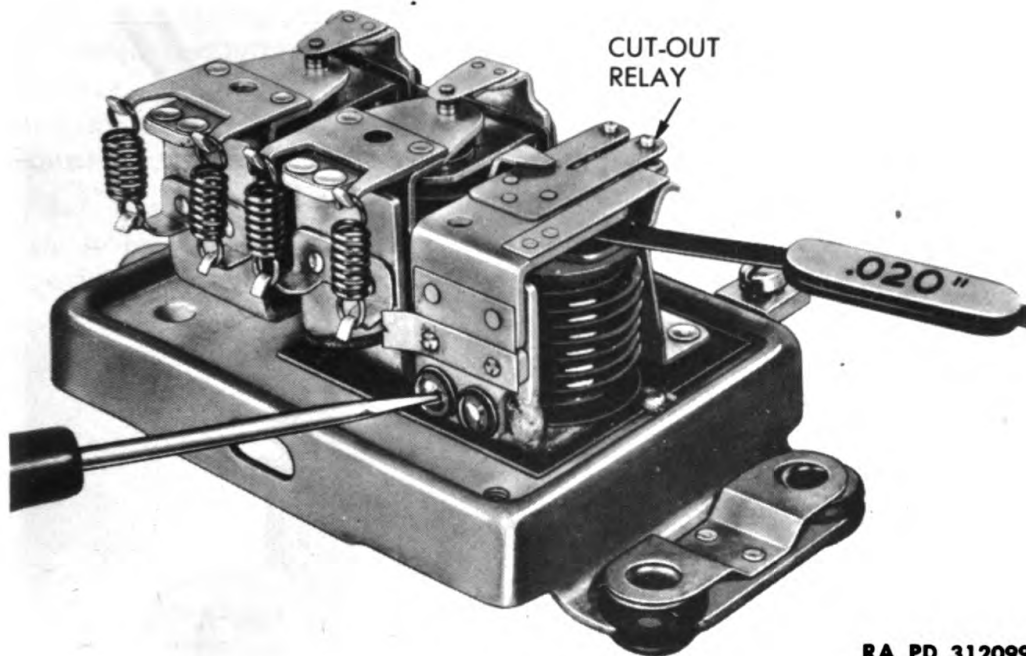


Figure 76—Upper Contact Support Arrangement

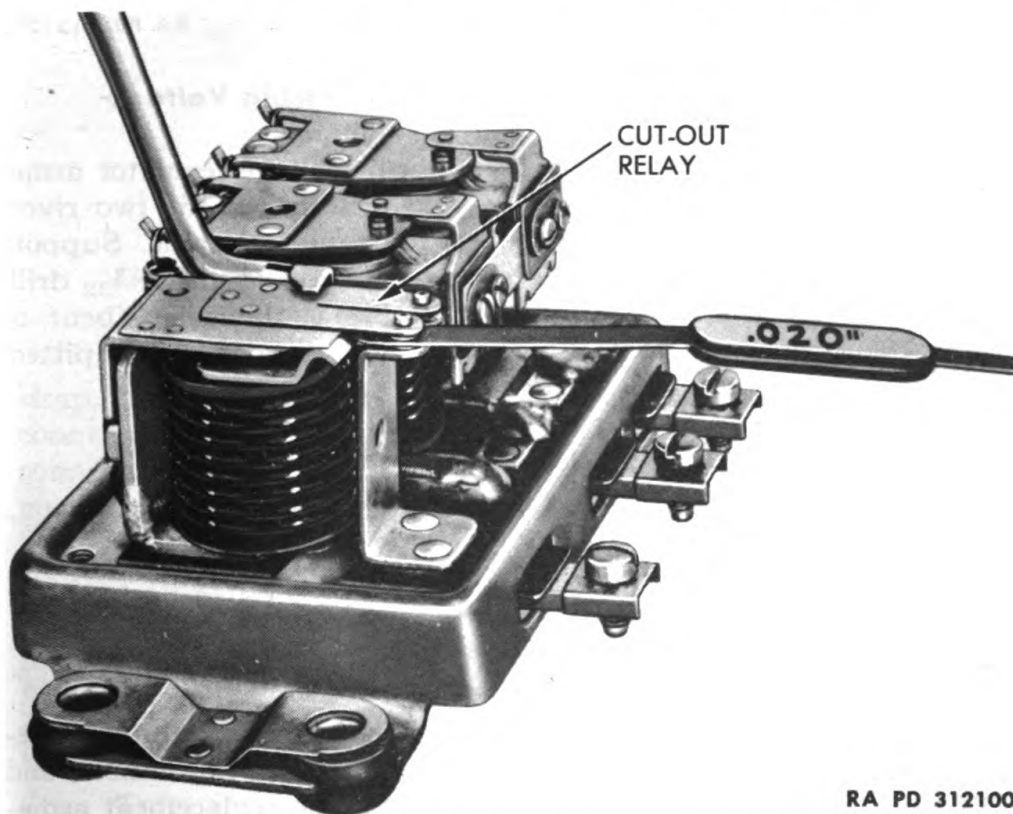
e. Remove voltage regulator upper contact support by removing two screws, two-hole lock washer, two-hole insulator, two small bushings, upper contact support, and two-hole insulator. If the current regulator upper contact support has been removed, the connector strap will also come off with voltage regulator upper contact support.

**GROUP III—CURRENT AND VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**



RA PD 312099

Figure 77—Adjusting Cut-out Relay Air Gap



RA PD 312100

Figure 78—Adjusting Cut-out Relay Point Opening

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

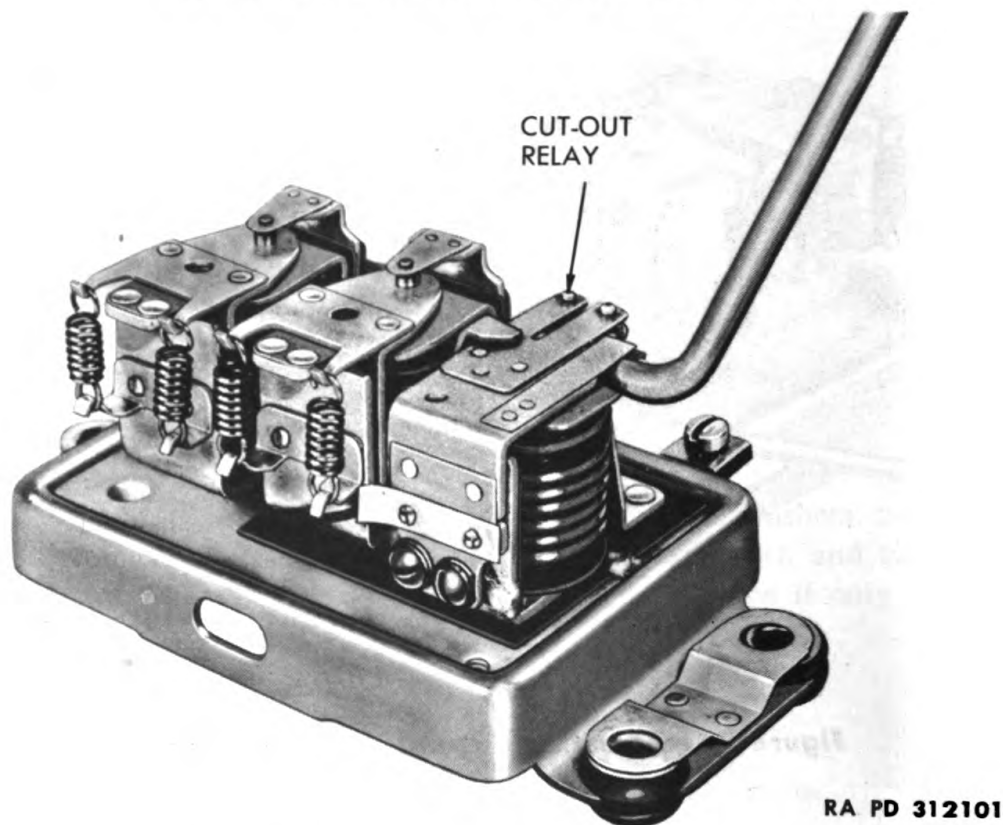


Figure 79—Adjusting Cut-out Relay Closing Voltage

f. Remove either the current regulator or voltage regulator armature by removing two spiral springs and drilling out the two rivets which mount armature springs hinge to regulator frame. Support frame to avoid bending it, center punch rivet head and use $\frac{3}{32}$ drill. This should be done only if the armature is damaged (bent or cracked spring), or if contact point is badly burned away, pitted, or worn.

66. CLEANING, INSPECTION, AND TEST OF PARTS.

- a. Refer to paragraph 58 and figure 75.

67. REPAIR OF PARTS.

- a. Refer to paragraph 59.

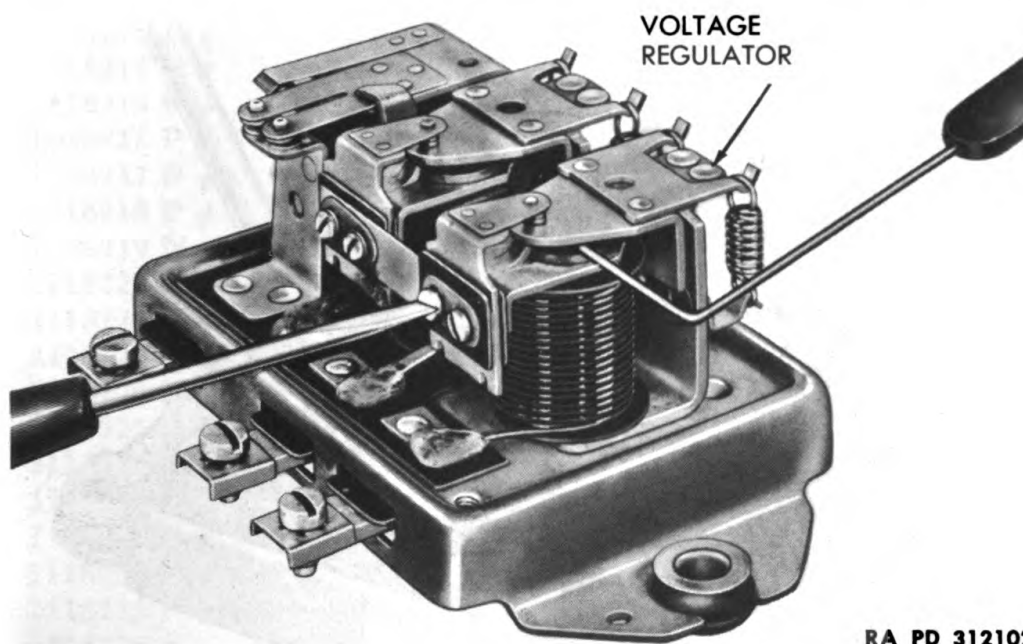
68. ASSEMBLY.

- a. If the regulator armatures have been removed, the replacement armatures can be installed with the screws, lock washers, and nuts which are furnished in the package with the replacement armature. Turn screws down so they will not ground against cover when the cover is replaced.

**GROUP III—CURRENT AND VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**

b. Install voltage regulator upper contact support (fig. 76). A two-hole insulator goes next to the regulator frame, then the upper contact support, two small bushings, the connector strap, two-hole insulator, two-hole lock washer, and two screws. Note that this connects the connector strap to the upper contact support.

c. Install current regulator upper contact support (fig. 76). A two-hole insulator goes next to the regulator frame, then the upper contact support, two small bushings, two-hole insulator, connector



RA PD 312102

Figure 80—Adjusting Regulator Air Gap (Current and Voltage Regulator Units)

strap, two-hole insulator, and two screws. Note that this connects the connector strap through the two screws to the regulator frame. The connector strap is insulated from the upper contact support on the current regulator. Resolder lead to upper contact support.

d. Install relay armature with two screws and lock washers. Resolder lead to armature.

e. Install four spiral springs on regulator armatures. The unit is now ready for check and adjustment.

69. TESTS AND ADJUSTMENTS.

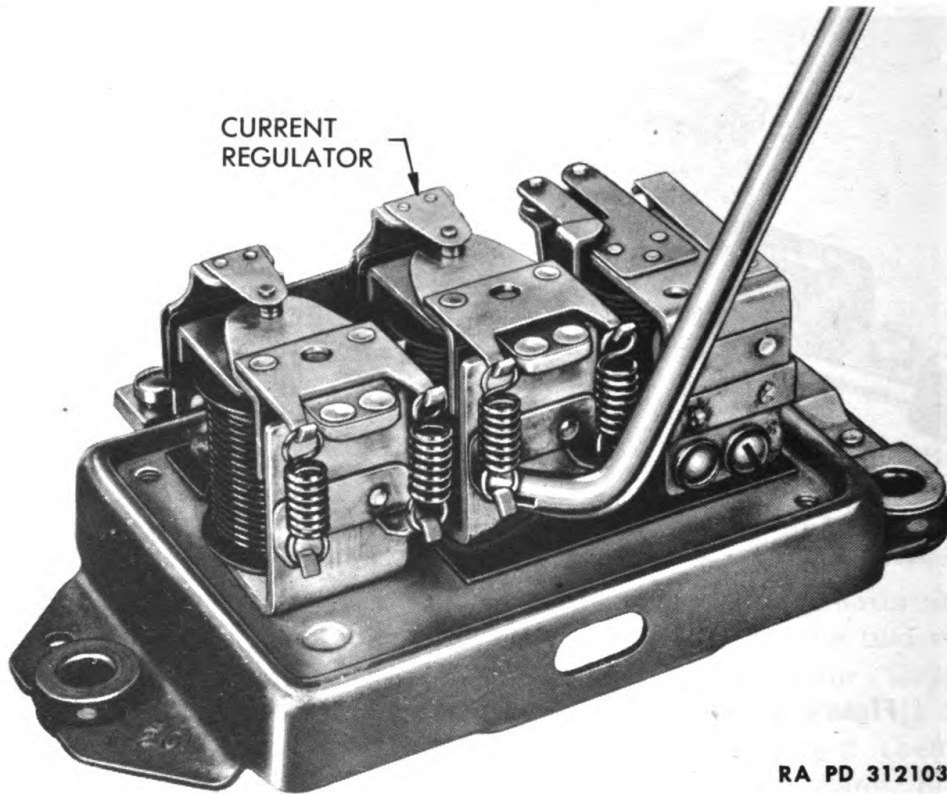
a. Tests and adjustments are divided into two parts, mechanical and electrical. Electrical tests were outlined in paragraph 64, mechanical tests are outlined below.

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

b. **Cut-out Relay.** With unit disconnected, refer to figures 77, 78, and 79 and follow procedure outlined in paragraph 53 b. Closing voltage is checked as outlined in paragraph 56 c.

c. **Voltage Regulator.** With unit disconnected, refer to figures 80 and 81, and follow procedure in paragraph 61 c.

d. Check current regulator setting as already detailed (par. 64 c (3)), and adjust, regardless of method used, by bending the lower spring hanger of one spring down to increase setting, or bend up to lower it (fig. 81). *NOTE: If spiral springs have been removed, replace*



RA PD 312103

Figure 81—Adjustment of Current Regulator Setting and/or Voltage Regulator Setting

one, make adjustment on it to obtain $\frac{1}{2}$ total current regulator setting. Install second spring and complete adjustment on second spring only. This insures that each spring will carry $\frac{1}{2}$ total tension.

70. SPECIFICATIONS.

a. **Group III Regulators—Current and Voltage Regulators used with Type One Generators.** (See table on next page.)

Voltage Regulator Air Gap	0.070 inch
Current Regulator Air Gap	0.080 inch
Cut-out Relay Air Gap	0.020 inch
Cut-out Relay Point Opening	0.020 inch

**GROUP III—CURRENT AND VOLTAGE REGULATORS FOR
TYPE ONE GENERATORS**

Model	Current Regulator Current Setting (Amps) Hot†	Voltage Regulator Voltage Setting (Closed Circuit) * Hot†	Cut-out Relay Points Close (Volts) Hot†
1118201 N #	32-34	7.2- 7.4	6.2- 6.7
1118202 P #	32-34	7.2- 7.4	6.2- 6.7
1118207 N #	28-30	7.0- 7.2	6.2- 6.7
1118208 P #	28-30	7.0- 7.2	6.2- 6.7
1118209 N #	16-18	14.0-14.2	12.4-13.4
1118210 P #	16-18	14.0-14.2	12.4-13.4
1118212 P #	38-40	7.0- 7.2	6.2- 6.7
1118214 P #	24-26	14.0-14.2	12.4-13.4
1118215 P #	22-24	7.0- 7.2	6.2- 6.7
1118217 P #	19-21	14.0-14.2	12.4-13.4
1118218 P #	7- 9	14.0-14.2	12.4-13.4
1118219 N #	24-26	14.0-14.2	12.4-13.4
1118220 P #	12-13	14.0-14.2	12.4-13.4
1118221 N #	26-28	7.0- 7.2	6.2- 6.7
1118222 P #	34-36	7.0- 7.2	6.2- 6.7
1118224 N #	12.5-13.5	7.4- 7.6	6.3- 6.9
1118225 P #	14-16	14.0-14.2	12.4-13.4
1118229 N #	34-36	7.0- 7.2	6.2- 6.7
1118230 P #	26-28	7.0- 7.2	6.2- 6.7
1118232 P #	34-36	7.0- 7.2	6.2- 6.7
1118234 P #	24-26	7.0- 7.2	6.2- 6.7
1118235 P #	9-11	14.0-14.2	12.4-13.4
1118236 †	26-28	7.0- 7.2	6.2- 6.7
1118237 N #	38-40	7.0- 7.2	6.2- 6.7
1118240 N #	18-20	7.1- 7.3	6.2- 6.7
1118241 P #	30-32	14.0-14.2	12.4-13.4
1118244 P #	48-50	6.8- 6.9	6.1- 6.4
1118245 P #	38-40	13.6-13.8	12.4-13.0
1118248 P #	9-11	14.0-14.2	12.4-13.4
1118249 P #	14.5-15.5	7.0- 7.2	6.2- 6.7
1118252 N #	24-26	14.0-14.2	12.4-13.4
1118253 P #	28-30	7.0- 7.2	6.2- 6.7
1118254 N #	12-13	14.0-14.2	12.4-13.4

†Insulated.

†Hot—Operating temperature.

*Operate generator at the speed at which it will produce rated output and adjust current to 8-10 amps.

*** CAUTION: These regulators are designed for operation with a particular polarity system. Using a regulator which is designed for operation on a positive grounded system with a battery which has the negative terminal grounded will quickly destroy the regulator.**

N—Negative.

P—Positive.

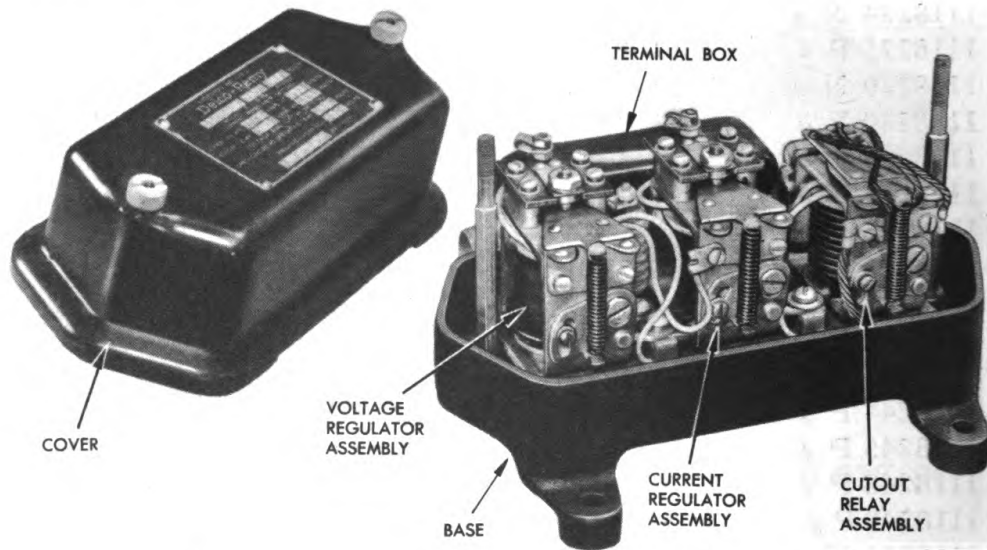
**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

**CHAPTER 3
REGULATORS (Cont'd)**

Section V

**GROUP IV—CURRENT AND VOLTAGE REGULATORS
FOR TYPE TWO GENERATORS**

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Description	71
Cleaning, inspection, and test	72
Disassembly	73
Cleaning, inspection, and test of parts	74
Repair of parts	75
Assembly	76
Tests and adjustments	77
Specifications	78



RA PD 312130

Figure 82—Current and Voltage Regulator for Type Two Shunt Generator

71. DESCRIPTION.

a. The current and voltage regulators (fig. 82) in this group are for use with shunt, type two generators. They include a cut-out relay, a voltage regulator, and a current regulator, all mounted on the same base and enclosed by the same cover. Some have a terminal shield which encloses the terminals and provides fittings for radio interference shielding.

GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR TYPE TWO GENERATORS

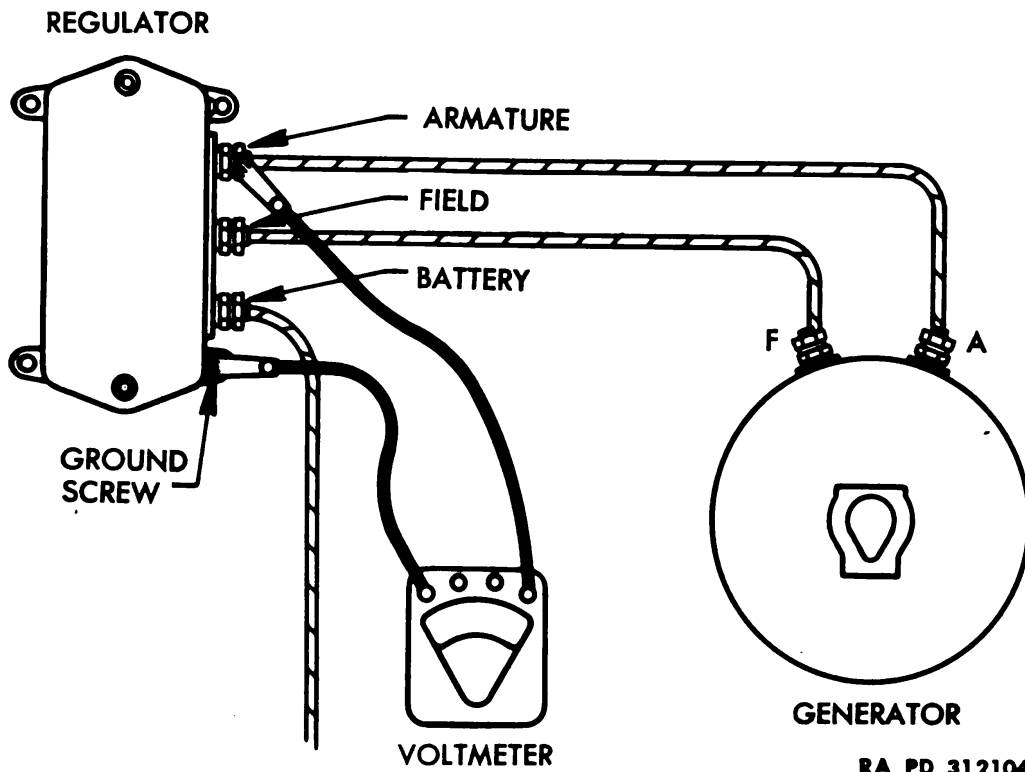


Figure 83—Cut-out Relay Closing Voltage Check

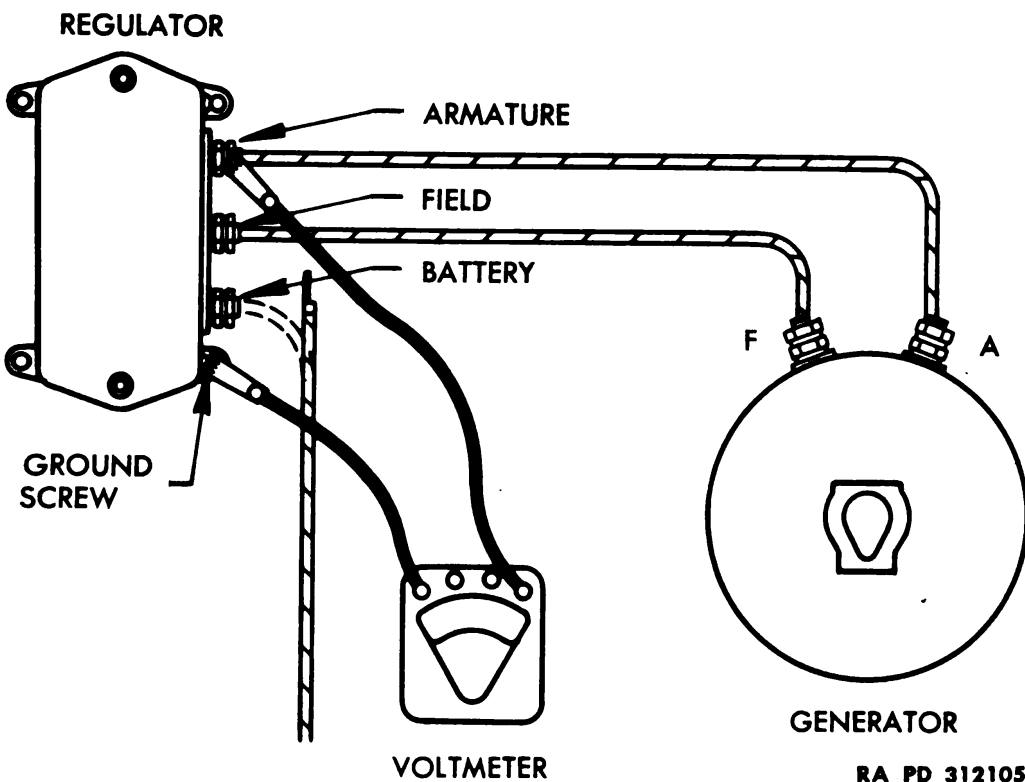


Figure 84—Voltage Regulator Setting Check

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

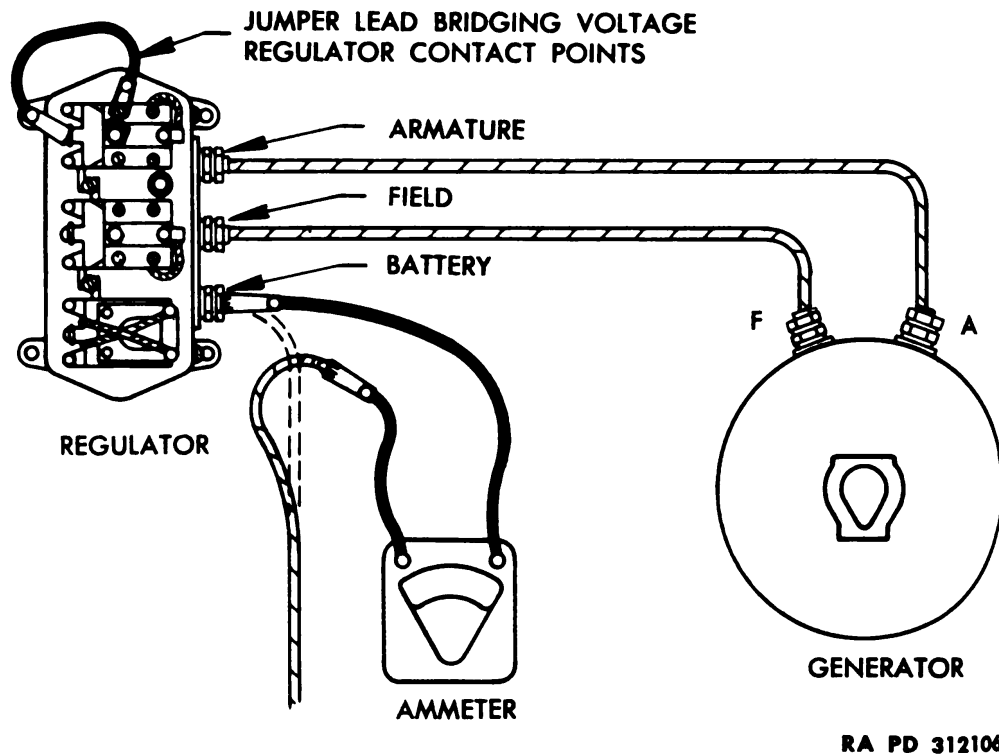
72. CLEANING, INSPECTION, AND TEST.

a. Clean by wiping off excess dirt with a clean cloth. Do not wash, steam, or dip-clean. Remove cover and blow out dirt or dust with compressed air, being careful to avoid directing air stream against leads, resistances, windings or other parts that could be damaged.

b. Inspect for burned contact points, resistances, windings, leads, or insulation.

c. Test with unit connected to proper generator and battery.

(1) Test cut-out relay closing voltage (fig. 83) by connecting voltmeter between the regular armature terminal and the ground return screw. Slowly increase generator speed, and note relay closing voltage.



RA PD 312106

Figure 85—Checking Current Regulator Setting with Jumper Lead

(2) Test voltage regulator setting by disconnecting lead from regulator battery terminal and connecting voltmeter from regulator armature terminal to the ground return screw (fig. 84). Operate generator at medium speed and note voltage setting. Regulator must be at operating temperature (145°). Either heat regulator in oven (avoid excessive baking or heat), or operate regulator about 45 minutes with cover on to obtain this temperature.

(3) Test current regulator setting by referring to figures 85 and 73 and following procedure in paragraph 64 c (3).

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**

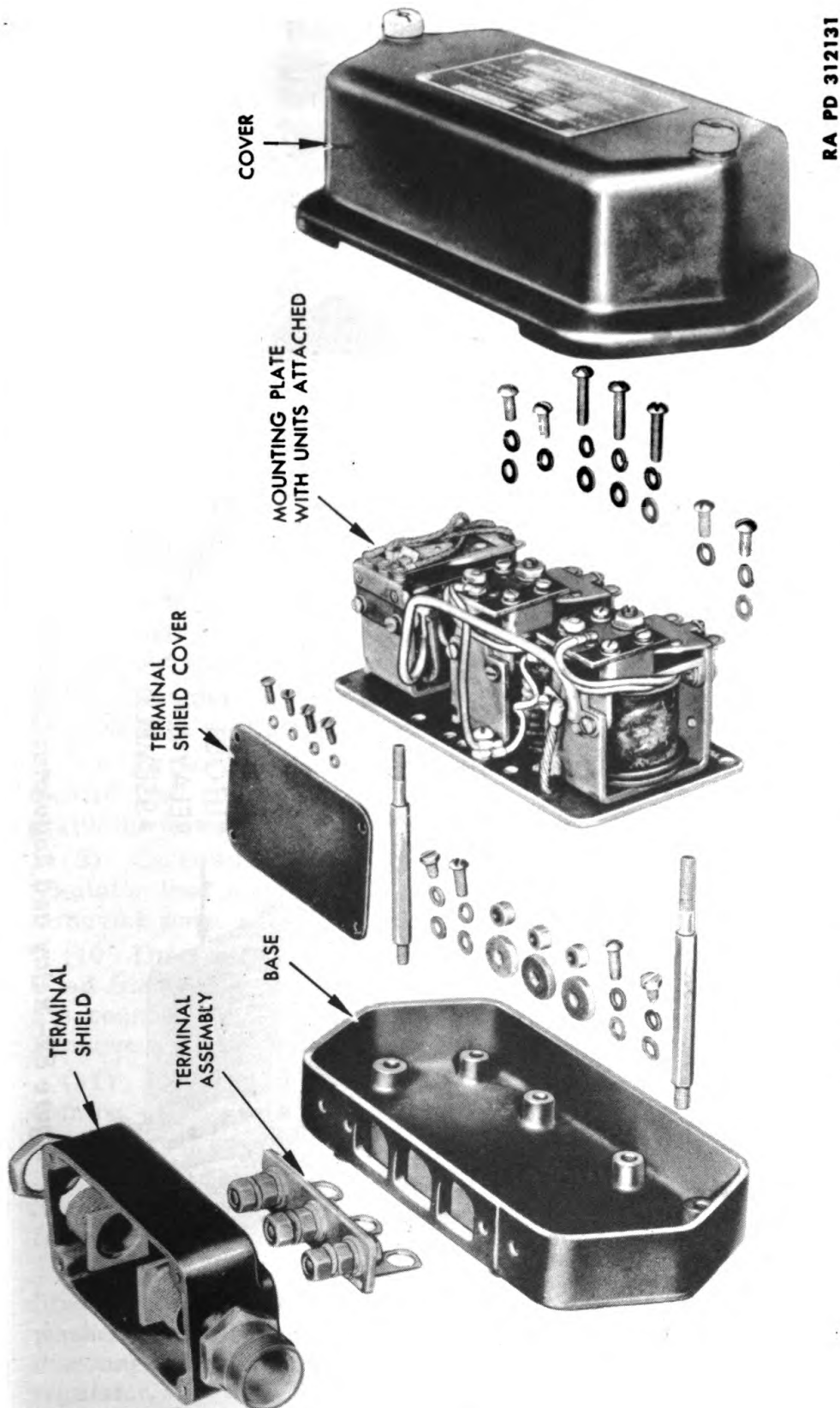
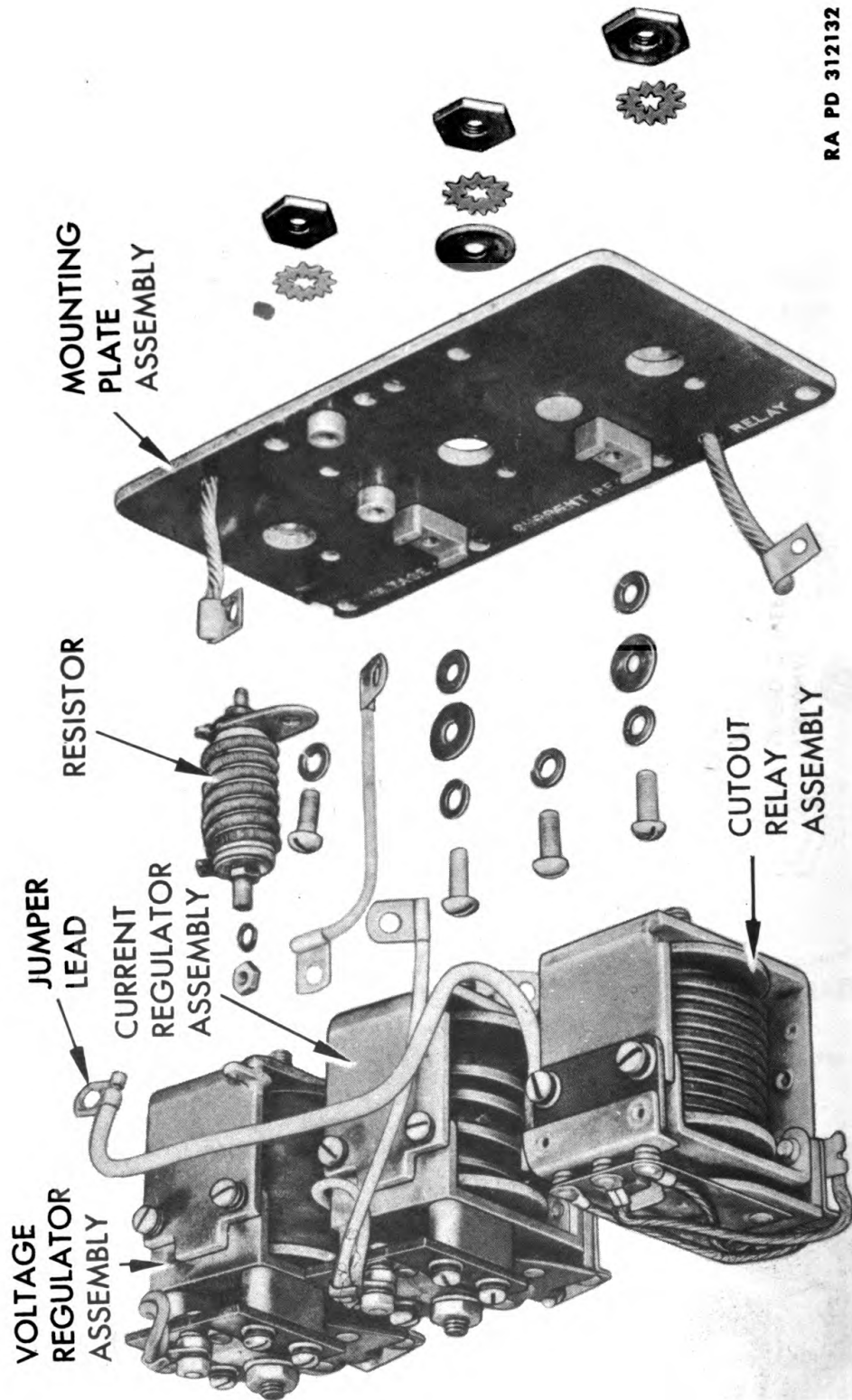


Figure 86—Current and Voltage Regulator, Disassembled

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312132

Figure 87—Relay and Regulator Units Detached from Mounting Plate

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**

73. DISASSEMBLY.

a. Disassemble Into Main Subassemblies (figs. 86 and 87).

- (1) REMOVE COVER. Unscrew two round nuts.
- (2) REMOVE TERMINAL SHIELD COVER (where present). Take out four screws and lock washers.
- (3) REMOVE TERMINAL SHIELD (where present). Remove by taking out two screws and lock washers.
- (4) DISCONNECT HEAVY REGULATOR LEADS. Unsolder and remove in order named, lead clamping screw, lock washer, and flat washer which clamp the two heavy leads together between voltage regulator and current regulator. Unsolder the two heavy leads from the clamp and remove washer from bottom of clamp.
- (5) DISCONNECT HEAVY RELAY AND REGULATOR LEADS. Unsolder and remove in order named, lead clamping screw, lock washer, and flat washer which clamp the two heavy leads together between current regulator and cut-out relay. Unsolder the two heavy leads from the clamp and remove washer from bottom of clamp.
- (6) DISCONNECT LEADS FROM RELAY CONTACT BRACKET. Holding leads with pliers to avoid burning fingers, unsolder cut-out relay series winding lead (heavy, black), cut-out relay shunt winding lead (small, light), and jumper lead (enclosed in yellow insulation) from the cut-out relay contact bracket.
- (7) REMOVE JUMPER LEAD. Disconnect other end of jumper lead from voltage regulator by removing screw and lock washer.
- (8) DISCONNECT VOLTAGE REGULATOR FRAME LEAD. Disconnect clip of lead coming up through fiber mounting plate from voltage regulator frame by removing screw and lock washer.
- (9) DISCONNECT VOLTAGE REGULATOR LEAD. Disconnect voltage regulator lead from current regulator frame (spiral spring side) by removing screw and lock washer.
- (10) DISCONNECT CURRENT REGULATOR SHUNT WINDING LEAD. Lead from resistance and lead from current regulator shunt winding are connected together at a tapped collar in fiber mounting plate. Remove screw and lock washer to disconnect these two leads.
- (11) DISCONNECT RELAY FRAME LEAD. Disconnect clip of lead coming up through fiber mounting plate from cut-out relay frame (spiral spring side) by removing screw and lock washer.
- (12) UNSCREW THREE MOUNTING PLATE SCREWS. Remove three fiber mounting, plate mounting screws, lock washers, and flat washers, from terminal side of fiber mounting plate.
- (13) UNSCREW FOUR MOUNTING PLATE SCREWS. Remove four fiber mounting plate mounting screws, four lock washers, and two flat washers from fiber mounting plate (on side with lettering). This also disconnects a lead from the cut-out relay, and a lead from the voltage regulator.

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

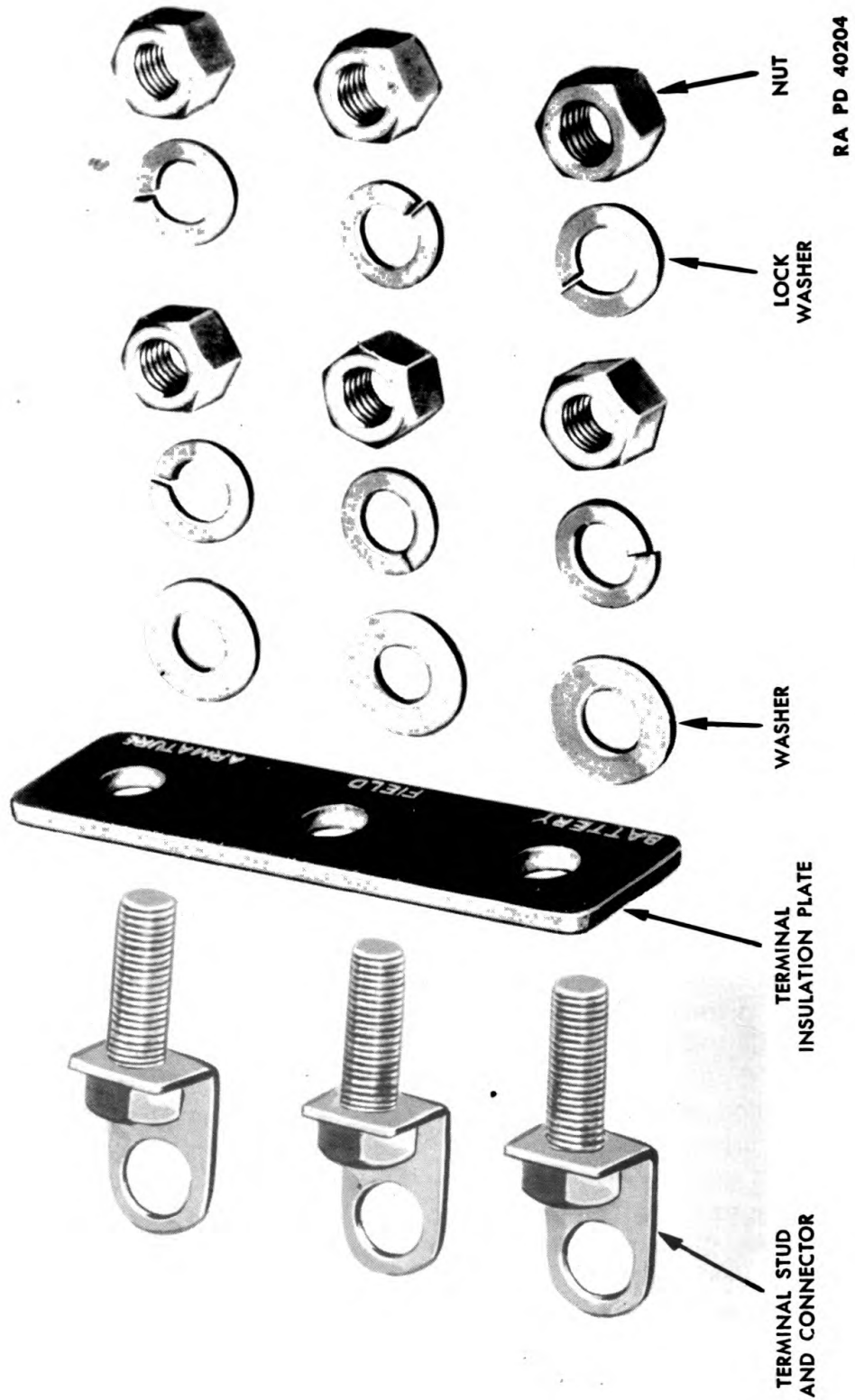
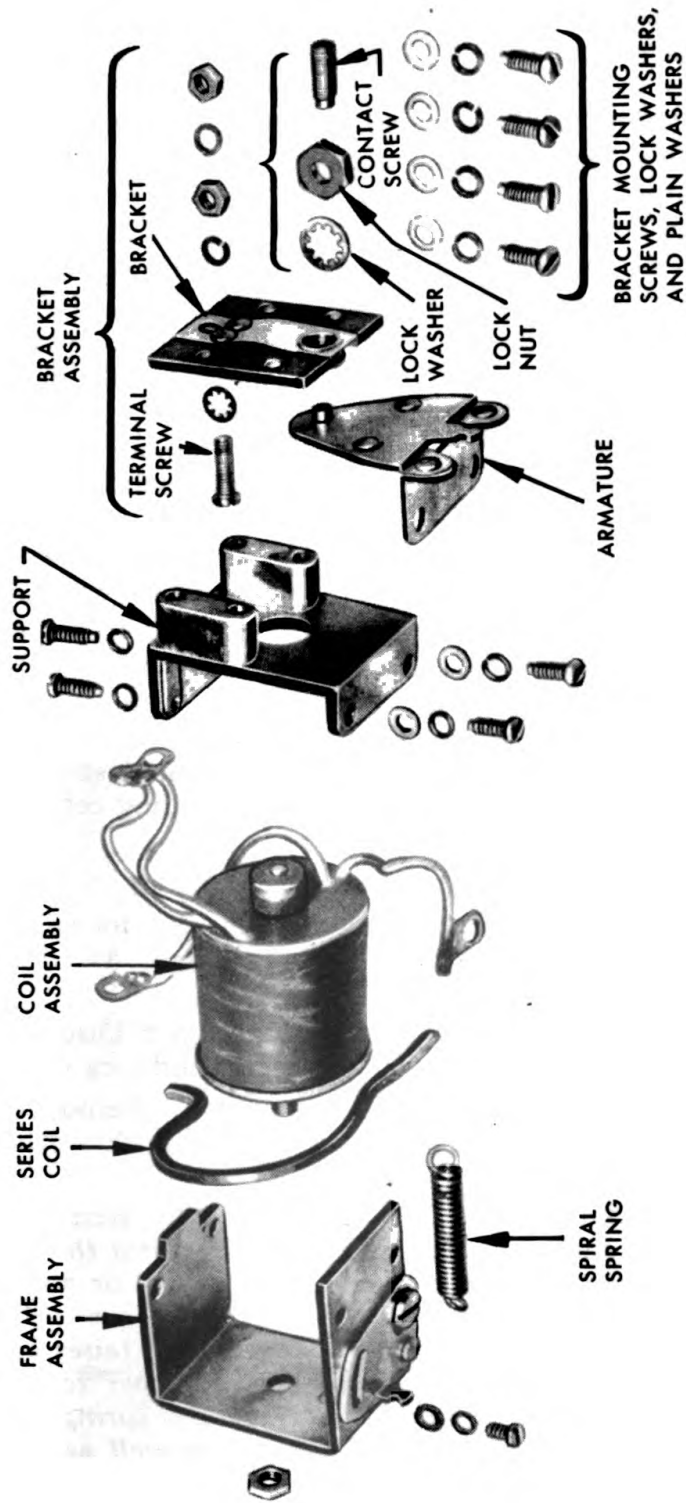


Figure 88—Terminal Assembly, Disassembled

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**



RA PD 312133

Figure 89—Voltage Regulator, Disassembled

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

(14) **LIFT OFF MOUNTING PLATE AND REGULATOR ASSEMBLY.** Remove the fiber mounting plate with cut-out relay and regulators from the regulator base.

(15) **LIFT OUT TERMINAL CONNECTOR INSULATING WASHERS AND BUSHINGS.** Remove three large fiber insulating washers, and three small fiber insulating bushings from the regulator base.

(16) **LIFT OFF TERMINAL ASSEMBLY.** Remove terminal assembly from the regulator base.

(17) **REMOVE VOLTAGE REGULATOR (fig. 87).** Remove voltage regulator from fiber mounting plate by removing nut and lock washer from stud on under side of plate.

(18) **REMOVE CURRENT REGULATOR (fig. 87).** Remove current regulator from fiber mounting plate by removing nut, lock washer, and flat washer, from stud on under side of plate.

(19) **REMOVE CUT-OUT RELAY (fig. 87).** Remove cut-out relay from mounting plate by removing nut and lock washer from stud on under side of plate.

(20) **REMOVE RESISTANCE (fig. 87).** Remove resistance assembly from fiber mounting plate by removing screw and lock washer.

(21) **DISCONNECT LEAD FROM RESISTANCE.** Disconnect lead from resistance assembly by removing nut and lock washer.

(22) **DISASSEMBLE TERMINAL ASSEMBLY (fig. 88).** Disassemble terminal assembly by removing two nuts, two lock washers, and one flat washer from each terminal stud. Hold terminal stud with one wrench, loosen nuts with other wrench. Avoid bending connector lugs soldered to the terminal studs.

b. Disassembly of Voltage Regulator (fig. 89).

(1) **REMOVE SPIRAL SPRING.** Hold voltage regulator spiral spring with pliers, unsolder from armature and remove. Avoid crushing spring with pliers.

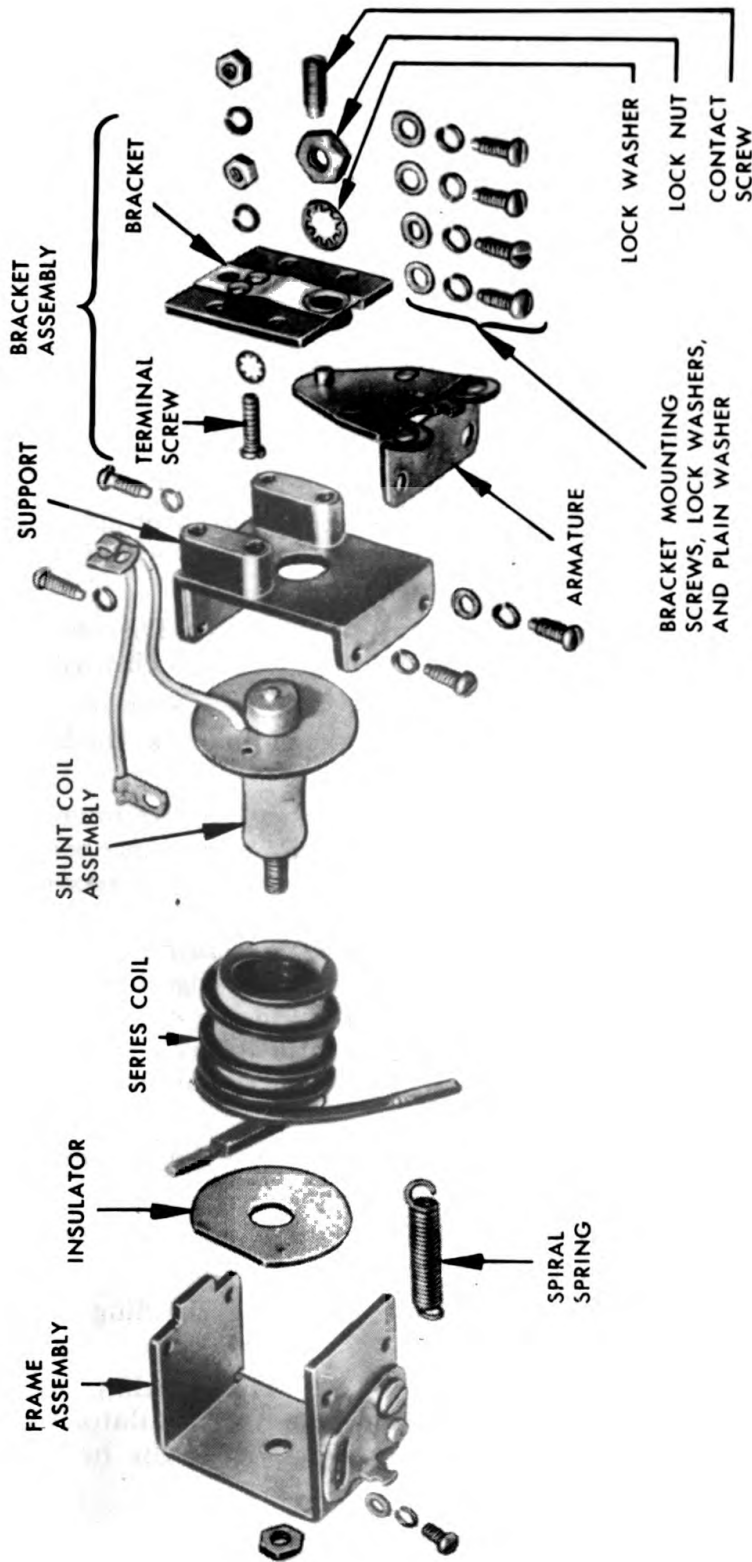
(2) **DISCONNECT LEAD FROM CONTACT BRACKET.** Disconnect lead from contact bracket assembly by removing nut and lock washer.

(3) **REMOVE CONTACT BRACKET ASSEMBLY.** Remove contact bracket assembly by removing four screws, four lock washers, and four flat washers.

(4) **DISASSEMBLE CONTACT BRACKET ASSEMBLY.** Remove contact screw, locking nut, and lock washer. *NOTE: Perform this operation at any time that the contact screw requires cleaning or replacement. Extreme care must be used during this operation to avoid bending the contact screw supporting spring. This flat spring raises up off the fiber bracket when the contact points come together to provide a wiping action between the points. Distorting the spring will cause severe damage to the regulator and generator as well as other electrical equipment. The correct procedure for removing the contact screw is illustrated in figure 97.*

(5) **REMOVE ARMATURE.** Remove armature by removing two screws, lock washers, and flat washers.

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**



RA PD 312134

Figure 90—Current Regulator, Disassembled

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

(6) **REMOVE CONTACT BRACKET SUPPORT.** The contact bracket support was originally held to the frame by the two armature mounting screws, lock washers, and flat washers, and the two screws and lock washers on the opposite side of the frame. When these four screws, four lock washers, and two flat washers have been removed, the contact bracket support may be removed.

(7) **REMOVE WINDING ASSEMBLY.** Remove winding assembly from frame by removing nut.

(8) **SERIES COIL.** Bend back the $\frac{3}{4}$ turn of heavy wire, which is the series coil, to permit removal of the winding assembly from the frame. Do not unsolder from the frame.

(9) **UNSCREW ADJUSTMENT LOCK SCREW.** If it should ever become necessary, the adjustment lock screw, lock washer, and flat washer may be removed from the frame.

c. Disassembly of Current Regulator (fig. 90).

(1) **REMOVE SPIRAL SPRING.** Hold current regulator spiral spring with pliers, unsolder from armature and remove. Avoid crushing spring with pliers.

(2) **DISCONNECT LEAD FROM CONTACT BRACKET.** Disconnect lead from contact bracket assembly by removing nut and lock washer.

(3) **REMOVE CONTACT BRACKET ASSEMBLY.** Remove contact bracket assembly by removing four screws, four lock washers, and four flat washers.

(4) **DISASSEMBLE CONTACT BRACKET ASSEMBLY.** Remove contact screw, locking nut, and lock washer. *NOTE: Perform this operation at any time that the contact screw requires cleaning or replacement. Extreme care must be used during this operation to avoid bending the contact screw supporting spring. This flat spring raises up off the fiber bracket when the contact points come together to provide a wiping action between the points. Distorting the spring will cause severe damage to the regulator and generator as well as other electrical equipment. The correct procedure for removing the contact screw is illustrated in figure 97.*

(5) **REMOVE ARMATURE.** Remove armature by removing two screws, two lock washers, and one flat washer.

(6) **REMOVE CONTACT BRACKET SUPPORT.** Remove the two screws and lock washers, and remove contact bracket support.

(7) **REMOVE WINDING ASSEMBLY.** Remove winding assembly from frame by removing nut.

(8) **DISASSEMBLE WINDING ASSEMBLY.** The winding assembly may be further disassembled by removing the fiber insulator from the serrations on the winding core, and then removing the heavy series winding.

(9) **UNSCREW ADJUSTMENT LOCK SCREW.** Remove the adjustment lock screw, lock washer, and flat washer from the frame, whenever necessary.

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**

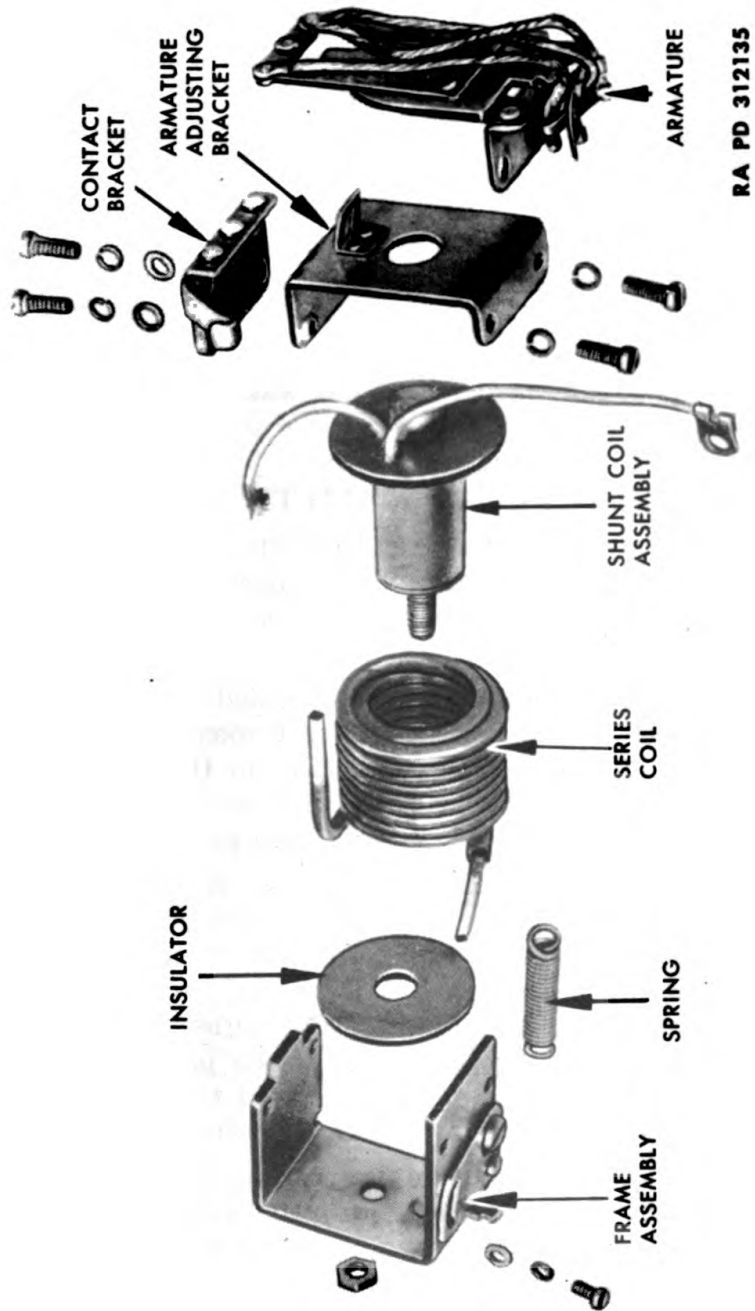


Figure 91—Cut-out Relay, Disassembled

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

d. Disassembly of Cut-out Relay (fig. 91).

(1) **REMOVE SPIRAL SPRING.** Hold cut-out relay spiral spring with pliers, unsolder from armature and remove. Avoid crushing spring with pliers.

(2) **REMOVE CONTACT BRACKET.** Remove two screws, lock washers, and flat washers, and remove contact bracket.

(3) **REMOVE ARMATURE.** Remove two screws, lock washers, armature, and remove armature stop bracket.

(4) **REMOVE WINDING ASSEMBLY.** Remove winding assembly from frame by removing nut.

(5) **DISASSEMBLE WINDING ASSEMBLY.** The winding assembly may be further disassembled by removing the fiber insulator from the serrations on the winding core, and then removing the heavy series winding.

(6) **UNSCREW ADJUSTMENT LOCK SCREW.** Remove the adjustment lock screw, lock washer, and flat washer from the frame, when necessary.

74. CLEANING, INSPECTION, AND TEST OF PARTS.

a. After disassembly, examine all parts, clean as necessary, and repair or replace defective parts. Particular attention must be given insulators; any found cracked, burned, or otherwise damaged must be replaced.

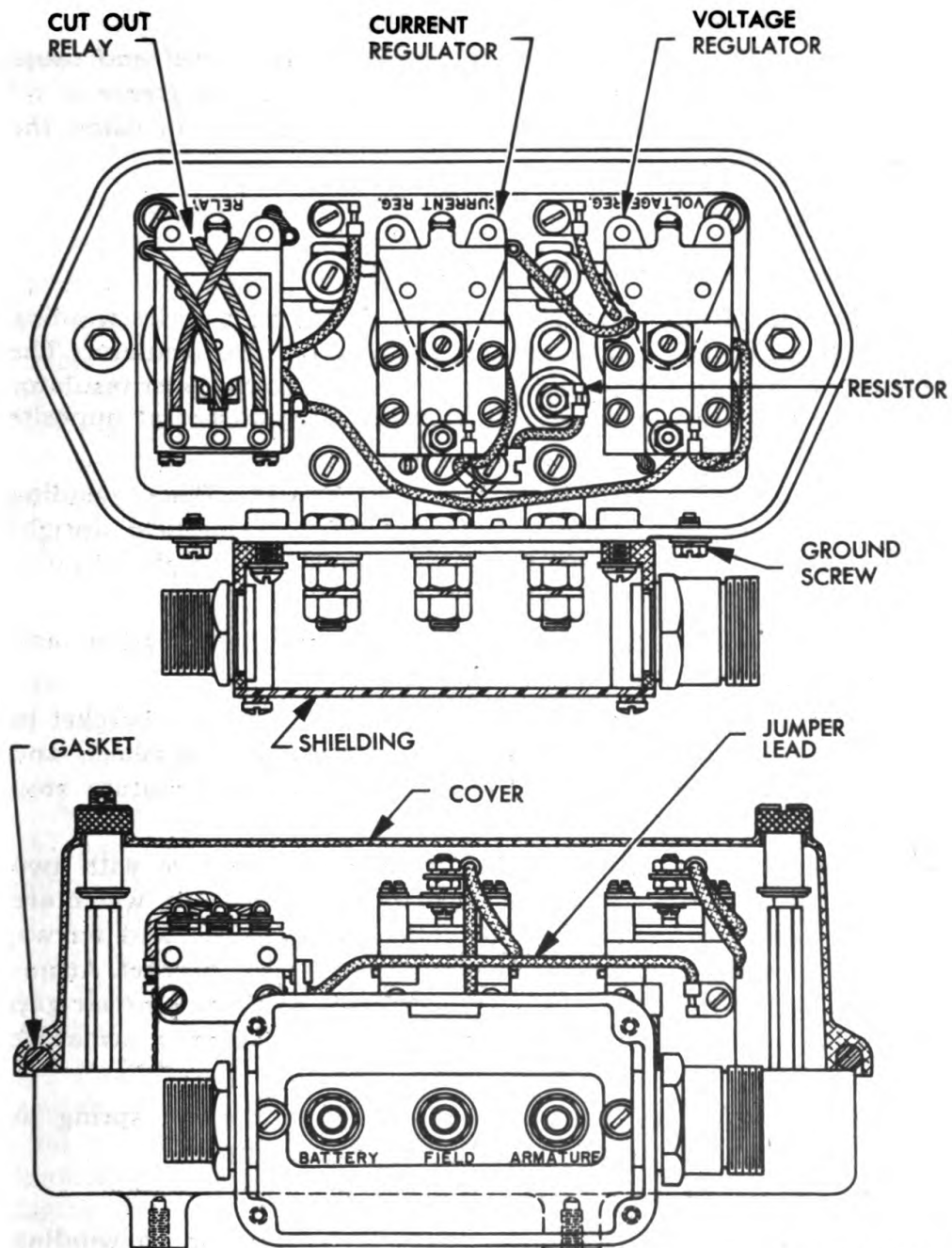
b. Winding assemblies must be handled with care, since they contain very fine wire which would be broken by rough treatment. The leads must not be twisted or pulled for the same reason. Make sure that the lead clips are well soldered to the leads and that the insulating tape on the outside of the windings is in place.

c. The cut-out relay armature, voltage regulator armature, and current regulator armature, all have contact points which must be examined for roughness and pits. Care must be taken in handling the armatures, since they have a flat armature spring which must not be bent or distorted. Damaging the flat spring will cause defective operation of the unit after assembly. If the points require cleaning, refer to paragraph 75 for procedure. Avoid touching point surfaces, since any trace of grease or oil may cause points to burn in operation.

d. Examine contact point of the contact screws on the voltage regulator and current regulator, for roughness or pits. Points are cleaned as outlined in paragraph 75. Avoid touching point surfaces, since any trace of grease or oil may cause the points to burn in operation.

e. The flat spring on the contact bracket of the voltage regulator and current regulator must not be distorted, and must have sufficient tension to rest firmly against fiber at free end. This provides a wiping action between the points in operation. Replace if defective.

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**



RA PD 30887

**Figure 92—Top and Front View of Regulator Showing
Relationship of Leads**

75. REPAIR OF PARTS.

a. Clean contact points which are pitted, excessively rough, burned, or dirty, with a clean, fine-cut contact file, or on a fine emery wheel or stone. **CAUTION: Do not remove more contact material**

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

than is absolutely necessary. Make sure all traces of emery or filings are removed from the point surfaces. Do not use emery cloth or sandpaper, since particles of emery or sand may embed and cause point burning. Do not touch point surfaces or get any grease or oil on them after cleaning, since traces of oil or grease will cause the points to burn in operation.

76. ASSEMBLY.

a. Assembly of Cut-out Relay (fig. 91).

(1) **INSTALL RELAY SERIES WINDING.** Place relay series winding over winding assembly and secure by pressing on fiber insulator. The straight lead on the series winding must be next to the fiber insulator and in line with two leads passing through fiber washer at opposite end of winding.

(2) **INSTALL WINDING ASSEMBLY IN FRAME.** Place winding assembly into frame and secure with nut. With frame held upright so short side is toward operator, all leads must be to right of operator (fig. 92).

(3) **INSTALL LOCK SCREW.** Install lock screw, lock washer, and flat washer into frame and tighten fingertight.

(4) **INSTALL CONTACT BRACKET.** Place armature stop bracket in place. Install contact bracket with two screws, lock washers, and flat washers. Screws go through frame and fasten armature stop bracket into place.

(5) **FASTEN ARMATURE TO FRAME.** Fasten armature with two screws and lock washers to frame. Fasten clips from leads, which are riveted to armature contact points under lock washers and screws, to frame. Screws go through frame into armature stop bracket. Armature must be pushed down tight against frame so there is no air gap between frame and armature. Use care to avoid damaging armature flat spring.

(6) **INSTALL SPIRAL SPRING.** With pliers, put spiral spring in place, hooking ends to armature and lower spring support.

b. Assembly of Current Regulator (fig. 90).

(1) **INSTALL SERIES WINDING.** Place series winding on winding assembly, and secure with fiber insulator.

(2) **ASSEMBLE WINDING ASSEMBLY INTO FRAME.** Place winding assembly into frame, and secure with nut. Heavy leads from series winding must be next to high side of frame. With frame held upright so short side is toward operator, the fine lead which passes through fiber washer at top of winding must be to right of operator (fig. 92).

(3) **INSTALL LOCK SCREW.** Install lock screw, lock washer, and flat washer into frame and tighten fingertight.

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(4) **FASTEN ARMATURE TO FRAME.** Place contact bracket support in position. Fasten armature to frame with two screws, two lock washers, and one flat washer. *NOTE: Screw to left, where clip fastens, does not have flat washer.* Armature must be pushed down tight against frame so there is no air gap between frame and armature. Use care to avoid damaging flat armature spring. Screws go through frame and fasten into U-shaped bracket.

(5) **INSTALL CONTACT BRACKET SUPPORT SCREWS.** Install other two screws and lock washers holding contact bracket support.

(6) **ASSEMBLE CONTACT BRACKET ASSEMBLY.** Assemble contact terminal screw with lock washer, through support bracket and secure with lock washer and nut. Place contact screw lock nut on contact screw. Place lock washer under nut, run screw down lightly into place in collar on flat contact spring on contact bracket assembly.

(7) **FASTEN BRACKET ASSEMBLY TO REGULATOR.** Fasten contact bracket assembly to regulator with four screws, lock washers, and washers.

(8) **FASTEN LEAD TO CONTACT BRACKET ASSEMBLY.** Fasten lead clip (with two leads) to contact terminal screw with nut and lock washer.

(9) **INSTALL SPIRAL SPRING.** With pliers, put spiral spring in place, hooking ends to armature and lower spring support.

c. Assembly of Voltage Regulator (fig. 89).

(1) **ASSEMBLE WINDING ASSEMBLY INTO FRAME.** Place winding assembly into frame and secure with nut. With frame held upright so short side is toward operator, the two leads attached to a single clip must be to right of operator (fig. 92).

(2) **INSTALL LOCK SCREW.** Install lock screw, lock washer, and flat washer into frame and tighten fingertight.

(3) **FASTEN ARMATURE TO FRAME.** Place contact bracket support in position. Fasten armature to frame with two screws, lock washers and flat washers. Armature must be pushed down tight against frame so there is no air gap between frame and armature. Use care to avoid damaging flat armature spring. Screws go through frame and fasten into contact bracket support.

(4) **INSTALL CONTACT BRACKET SUPPORT SCREWS.** Install remaining two screws and lock washers to secure contact bracket support.

(5) **ASSEMBLE CONTACT BRACKET ASSEMBLY.** Assemble terminal screw with lock washer through contact bracket assembly, and secure with lock washer and nut. Place contact screw lock nut on contact screw. Place lock washer under nut, and run screw down lightly into place in collar on flat contact spring on contact bracket assembly

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(6) **FASTEN BRACKET ASSEMBLY TO REGULATOR.** Fasten contact bracket assembly to regulator with four screws, lock washers, and washers.

(7) **FASTEN LEAD TO CONTACT BRACKET ASSEMBLY.** Fasten lead clip (with two leads) to contact terminal screw with nut and lock washer.

(8) **INSTALL SPIRAL SPRING.** With pliers, put spiral spring in place, hooking ends to armature and lower spring support.

d. Assembly of Regulator (figs. 86, 87, and 88).

(1) **ASSEMBLE TERMINAL ASSEMBLY.** Put three terminal studs into terminal plate. Secure each terminal with one flat washer, lock washer, and nut, in that order. Hold terminal stud with one wrench, and tighten nuts with other. Add three lock washers and nuts, and tighten fingertight.

(2) **FASTEN RESISTANCE LEAD.** Fasten resistance lead to resistance with lock washer and nut.

(3) **MOUNT RESISTANCE ON MOUNTING PLATE.** Mount resistance assembly on fiber mounting plate by placing end of resistance through bolt into hole in plate, and fastening resistance bracket to collar in plate with screw and lock washer (fig. 92).

(4) **FASTEN CUT-OUT RELAY TO PLATE.** Fasten cut-out relay assembly to fiber mounting plate with lock washer and nut (fig. 93).

(5) **FASTEN CURRENT REGULATOR TO PLATE.** Fasten current regulator assembly to fiber mounting plate with flat washer, lock washer, and nut (fig. 92).

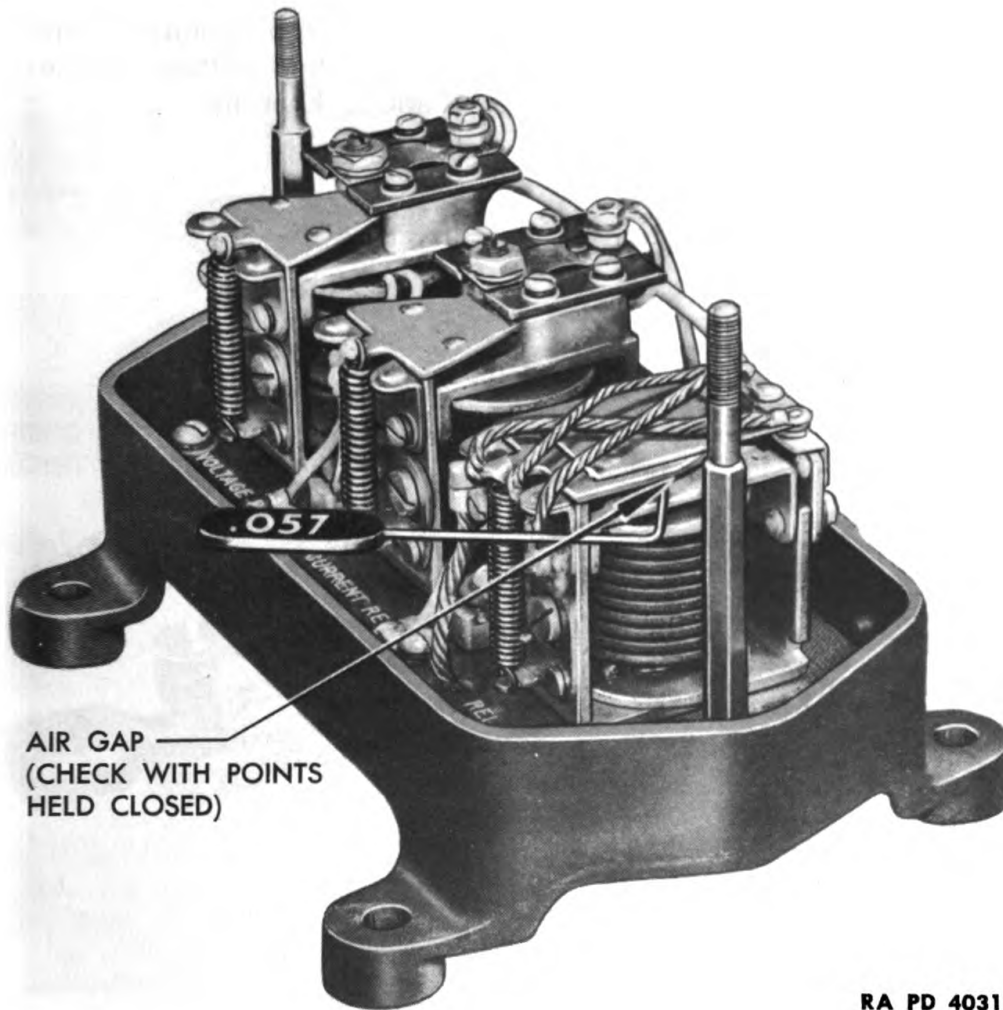
(6) **FASTEN VOLTAGE REGULATOR TO PLATE.** Fasten voltage regulator assembly to fiber mounting plate with lock washer and nut (fig. 92).

(7) **PLACE TERMINAL ASSEMBLY INTO REGULATOR BASE.** Place terminal assembly into position in regulator base. Put three insulating washers under three connector lugs on terminal screws, and place three fiber bushings through into holes in base.

(8) **ASSEMBLE FIBER MOUNTING PLATE (WITH REGULATORS AND RELAY UNIT) IN POSITION IN REGULATOR BASE.** Assemble fiber mounting plate with regulators and relay unit into position and secure with three washers, lock washers, and screws placed through holes in fiber mounting plate on terminal side of regulator. Assemble four screws (screwdriver), four lock washers, and two washers on other side of fiber mounting plate. The two flat washers go on screws at two end holes. The other two screws also fasten two lead clips (fig. 92). One lead is from the relay, the other lead is from the voltage regulator. **CAUTION: Care must be taken to connect the proper lead from the voltage regulator, since there are two leads of about the same length coming from the voltage regulator. Both leads**

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pass through the upper fiber washer of the voltage regulator winding assembly, but one lead comes through a hole nearer the center of the winding. Connect this lead to the fiber mounting plate with screw and lock washer. The other lead, passing through the hole further away from the center of the winding, connects to the current regulator frame (fig. 93).



RA PD 40311

Figure 93—Cut-out Relay Air Gap Check

(9) **CONNECT SECOND LEAD FROM VOLTAGE REGULATOR.** Connect clip of second lead from voltage regulator to current regulator frame (fig. 92). Remove screw and lock washer from current regulator frame to connect clip, replace and tighten.

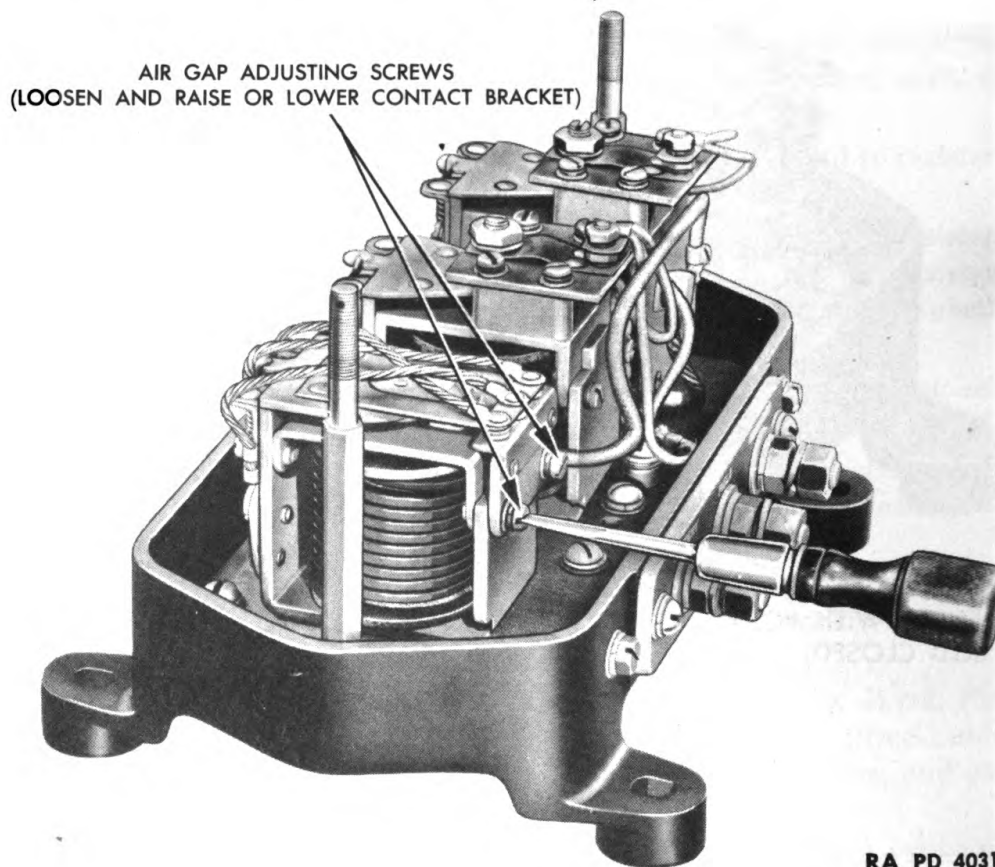
(10) **CONNECT CURRENT REGULATOR LEAD.** Connect clip of lead from current regulator and clip of lead from resistance to tapped collar in fiber mounting plate with screw and lock washer.

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(11) **CONNECT JUMPER LEAD.** Connect clip on jumper lead (yellow insulation) to voltage regulator frame by removing and replacing screw and lock washer. The opposite end of jumper lead solders to the relay contact bracket.

(12) **CONNECT VOLTAGE REGULATOR FRAME LEAD.** Connect clip of lead coming up through fiber mounting plate to voltage regulator frame by removing and replacing screw and lock washer.

(13) **CONNECT CUT-OUT RELAY FRAME LEAD.** Connect clip of lead coming up through fiber mounting plate to voltage regulator frame by removing and replacing screw and lock washer.



RA PD 40312

Figure 94—Adjusting Cut-out Relay Air Gap

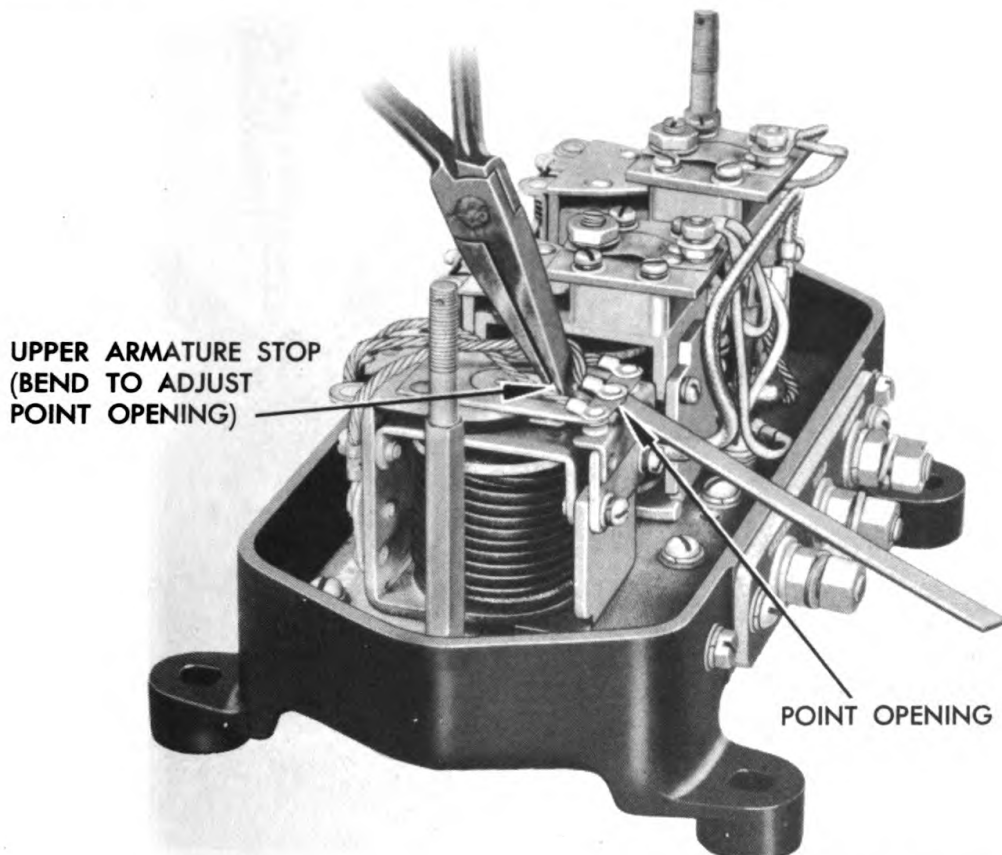
(14) **CONNECT HEAVY RELAY AND REGULATOR LEADS.** Place small washer in lead clamp in fiber mounting plate between current regulator and cut-out relay, put two heavy leads in place and secure with large washer, lock washer, and screw. Solder connections and screw securely with soldering iron. *NOTE: Do not use acid flux.*

(15) **CONNECT HEAVY REGULATOR LEADS.** Place small washer in lead clamp in fiber mounting base between current regulator and

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voltage regulator. Put two heavy leads in place and secure with large washer, lock washer and screw. Solder connections and screw securely with soldering iron. *NOTE: Do not use acid flux.*

(16) **CONNECT LEADS TO RELAY CONTACT BRACKET.** Place relay heavy series winding lead, relay shunt winding lead, and jumper lead (yellow insulation) in position in relay contact bracket and crimp bracket around leads. Solder securely, using a non-acid flux.



RA PD 40313

Figure 95—Cut-out Relay Point Opening Check and Adjustment

(17) **SOLDER SPIRAL SPRINGS TO ARMATURES.** Solder spiral springs to armatures of cut-out relay, current regulator, and voltage regulator. This holds springs in place, and prevents them from coming off in operation.

(18) **FASTEN TERMINAL SHIELD.** Fasten terminal shield in place with two screws, lock washers, and washers.

(19) **ASSEMBLE TERMINAL SHIELD COVER.** Assemble terminal shield cover with four screws and lock washers.

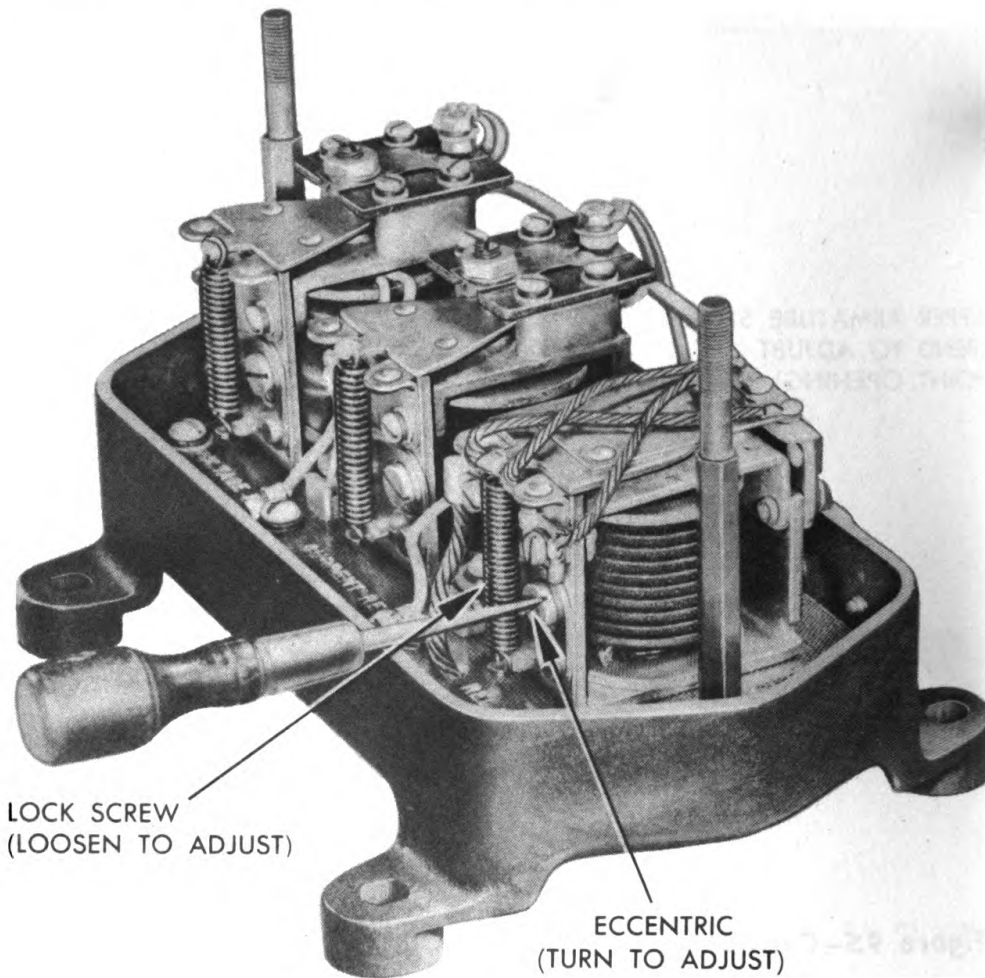
**ORDNANCE MAINTENANCE
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77. TESTS AND ADJUSTMENTS.

a. Tests and adjustments are divided into two parts, mechanical and electrical. Refer to paragraph 72 c for electrical tests. Outline for mechanical tests follows below.

b. **Cut-out Relay.** Proceed as follows with unit disconnected.

(1) Measure air gap (figs. 93 and 94) between the armature and the core (not between the brass pin in the armature and the core)



RA PD 40316

Figure 96—Adjusting Cut-out Relay Closing Voltage

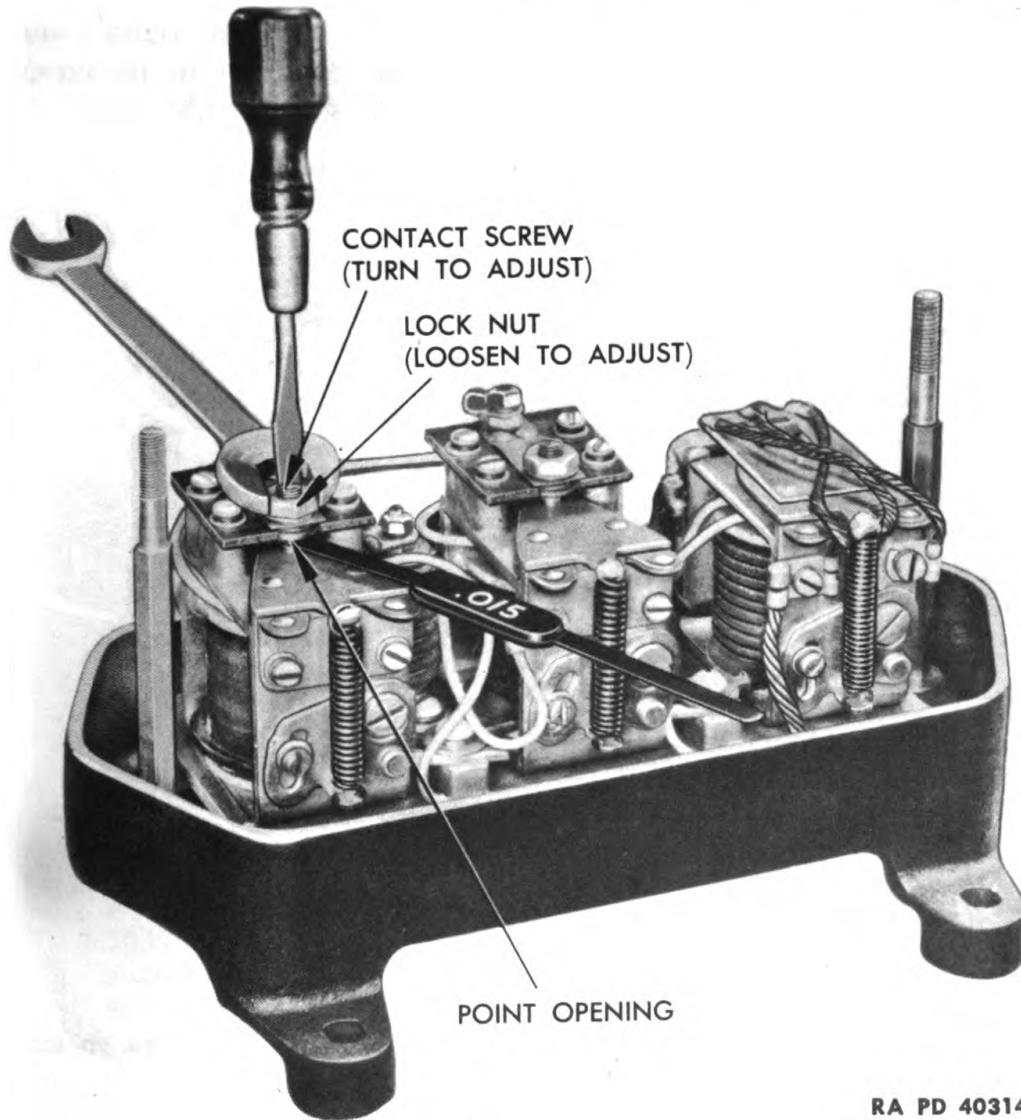
with the points just touching. Adjust by loosening the two contact mounting screws, and raising or lowering the bracket as required. Be sure the points are lined up. Tighten screws after adjustment.

(2) Measure point opening (fig. 95) with the points open, and adjust by bending the upper armature stop. If the points do not

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close at the same instant, the contact bracket must be slightly realigned (and air gap reset if necessary) and the spring fingers bent until they all close simultaneously.

(3) Check closing voltage as explained in paragraph 72 c (1) and adjust (fig. 96) by loosening the lock screw and turning the



RA PD 40314

Figure 97—Adjusting Regulator Point Opening

eccentric. Increasing the spring tension increases the closing voltage. After each adjustment, slow generator and bring back to speed, to check adjustment.

c. Voltage Regulator. Proceed as follows with unit disconnected.

(1) Measure point opening (fig. 97) with the armature held down against the winding core. Adjust by loosening the lock nut

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and turning the contact screws. Care must be used to avoid distorting the contact spring. The correct procedure is to place the screwdriver into the screw slot and hold the screw stationary while the lock nut is loosened. The spring must rise slightly above the insulator when the points come together. This provides a wiping section between the contact points that maintains better contact. After the correct adjustment is made, tighten the lock nut by holding the screw stationary with the screwdriver and using wrench to tighten nut.

(2) Check voltage regulator setting as explained in paragraph 72 c (2) and adjust (fig. 98) by loosening the lock screw and

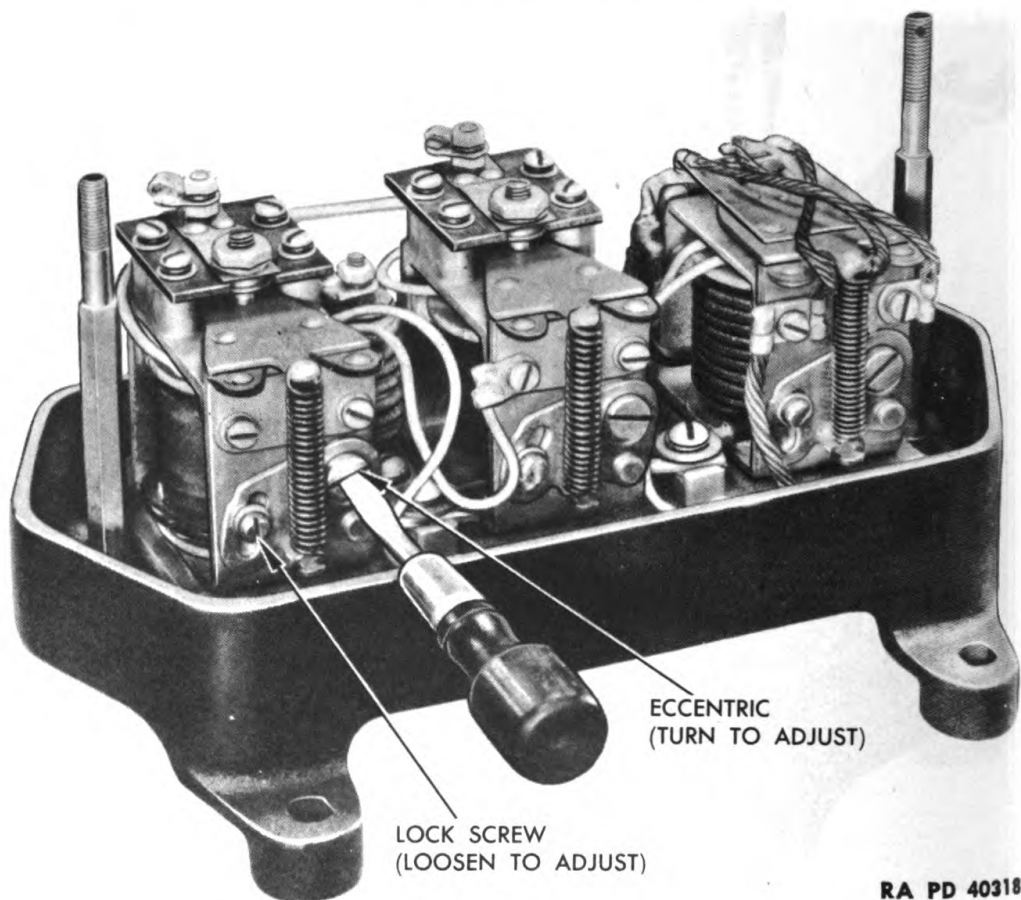


Figure 98—Adjusting Regulator

turning the eccentric. Increasing the spring tension increases the voltage setting.

d. Current Regulator. Proceed as follows with unit disconnected.

(1) Point opening is checked and adjusted as for voltage regulator (par. 77 c (1)).

(2) Current regulator setting is checked as explained in paragraph 72 c (3) and adjusted as for voltage regulator (par. 77 c (2)) by loosening the lock screw and turning eccentric.

**GROUP IV—CURRENT AND VOLTAGE REGULATORS FOR
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78. SPECIFICATIONS.

a. Group IV Regulators—Current and Voltage Regulators for Use with Type Two Generators.

Voltage Regulator Point Opening	0.015 in.
Current Regulator Point Opening	0.015 in.
Cut-out Relay Air gap	0.057 in.
Cut-out Relay Point Opening	0.020 in.
Cut-out Relay Points Open with 0-3.0 Amps Reverse Current	

Model	Current Regulator Current Setting (Amps)	VOLTAGE REGULATOR		Cut-out Relay Points Close (Volts)
		Voltage Setting (Open Circuit) 135°-145° F	Generator RPM for Voltage Setting	
5525 P #	40	15.0	1500	13.5
5534 P #	—	8.5	2000	7.0
5607 P #	40	40.0	1500	35.0
5611*	10	37.5	1500	33.0
5613 N #	20	15.0	1500	13.5
5615*	50	30.0	1500	26.0
5617*	40	37.5	1500	33.0
5618 P #	35	15.0	1500	13.5
5622 P #	25	37.5	1500	33.0
5623 P #	40	15.0	1500	13.5
5626 P #	10	30.0	1500	26.0
5629 P #	25	15.0	1500	13.5
5630 P #	25	30.0	1500	26.0
5632 P #	17	15.0	1500	13.5
5634 P #	55	15.0	2000	13.5
5635 N #	55	15.0	2000	13.5
5636 P #	57	15.0	1500	13.5
5637 P #	40	15.0	1500	13.5
5638 N #	55	15.5	2000	13.5
5639 N #	55	15.0	2000	13.5
5640 P #	35	7.5	2000	6.5-6.9
5641 N #	25	15.0	1500	13.5
5642 P #	10	37.5	1500	33.0
5643 P #	20	40.0	1500	35.0
5644 P #	25	40.0	1500	35.0
5645 P #	40	40.0	1500	35.0
5646 P #	25	30.0	1500	26.0

*—Insulated.

CAUTION: *These regulators are designed for operation with a particular polarity system. Using a regulator which is designed for operation on a positive grounded system with a battery which has the negative terminal grounded will quickly destroy the regulator.*

N—Negative.

P—Positive.

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GROUP IV REGULATORS (Cont'd)

Model	Current Regulator Current Setting (Amps)	VOLTAGE REGULATOR Voltage Setting (Open Circuit) 135°-145° F	Generator RPM for Voltage Setting	Cut-out Relay Points Close (Volts)
5647 P #	18	15.0	1500	13.5
5648 P #	33	15.0	2000	13.5
5649 P #	40	15.0	1500	13.5
1118451 P #	40	8.5	2000	7.0
1118453 N #	40	15.0	1500	13.5
1118455 P #	15	30.0	1500	26.0
1118456 P #	50	15.0	1500	13.5
1118457 P #	14	30.0	1500	26.0
1118458 P #	10	30.0	1500	26.0
1118459 P #	25	30.0	1500	26.0
1118461 P #	14	37.5	1500	33.0
1118462 N #	50	15.0	3000	13.5
1118463 P #	12	30.0	1500	26.0
1118464 P #	10	30.0	1500	26.0
1118465 P #	25	15.0	1500	13.5
1118467 N #	15	30.0	1500	26.0
1118468 N #	40	7.5	2000	6.5-6.9
1118469 P #	10	40.0	1500	35.0
1118470 N #	50	30.0	2000	26.0
1118471 P #	40	15.0	1500	13.5
1118472 N #	40	15.0	1500	13.5
1118473 N #	50	15.0	3000	13.5
1118474 P #	50	30.0	2000	26.0
1118475 P #	25	15.0	1500	13.5
1118476 P #	25	15.0	1500	13.5
1118477 P #	25	30.0	1500	26.0
1118478 N #	50	30.0	2000	26.0
1118482 N #	50	30.0	2000	26.0
1118483 N #	50	15.0	3000	13.5
1118484 P #	25	30.0	1500	26.0
1118485 N #	20	15.0	1500	13.5
1118486 N #	50	28.0	2000	26.0
1118487 N #	50	30.0	1800	26.0
1118488 N #	55	15.0	2000	13.5
1118490 N #	40	7.5	2000	6.5-6.9

*—Insulated. N—Negative. P—Positive.

CAUTION: These regulators are designed for operation with a particular polarity system. Using a regulator which is designed for operation on a positive grounded system with a battery which has the negative terminal grounded will quickly destroy the regulator.

**CHAPTER 3
REGULATORS (Cont'd)**

Section VI

**GROUP V—VOLTAGE REGULATORS FOR
TYPE TWO GENERATORS**

	Paragraph
Description	79
Cleaning, inspection, and test.....	80
Disassembly	81
Cleaning, inspection, and test of parts.....	82
Repair of parts	83
Assembly	84
Tests and adjustments	85
Specifications	86

79. DESCRIPTION.

a. The voltage regulators (fig. 99) in this group are for use with third brush type two generators. They include a voltage regulator and a cut-out relay, mounted on the same base and enclosed by the same cover. The voltage regulator unit, alone, is used to provide voltage regulation of the auxiliary engine generator on some applications (figs. 100 and 101).

80. CLEANING, INSPECTION, AND TEST.

a. **Clean.** Refer to paragraph 72 a.

b. **Inspect.** Refer to paragraph 72 b.

c. **Test.** Refer to paragraph 72 c (1) and (2), and figures 102 and 103. *NOTE: Type unit shown in figures 100 and 101 is tested on closed circuit with 10 amperes flowing (fig. 104); operate generator at 2500 rpm and adjust variable resistance to obtain 10 amperes.*

81. DISASSEMBLY.

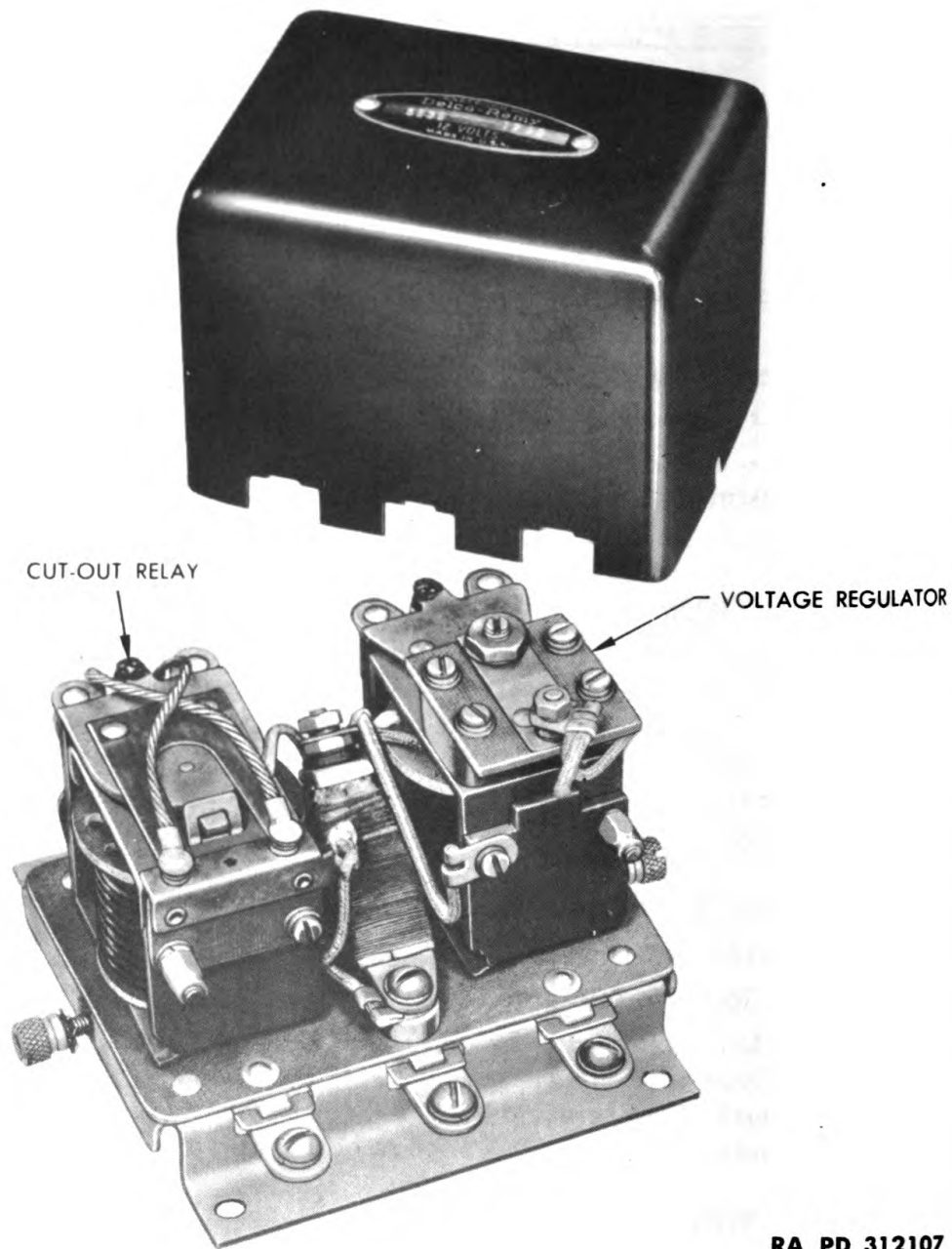
a. **Disassembly Into Main Subassemblies** (type shown in fig. 105).

(1) Remove cover by unscrewing the two cover lock nuts.

(2) Remove the screw and lock washer holding the resistance unit and voltage regulator series winding lead (enclosed in yellow insulation) to base.

(3) Remove the screw and lock washer holding the cut-out relay shunt winding lead (enclosed in yellow insulation) and voltage regulator main winding lead (enclosed in red insulation) to the grounded terminal on the base.

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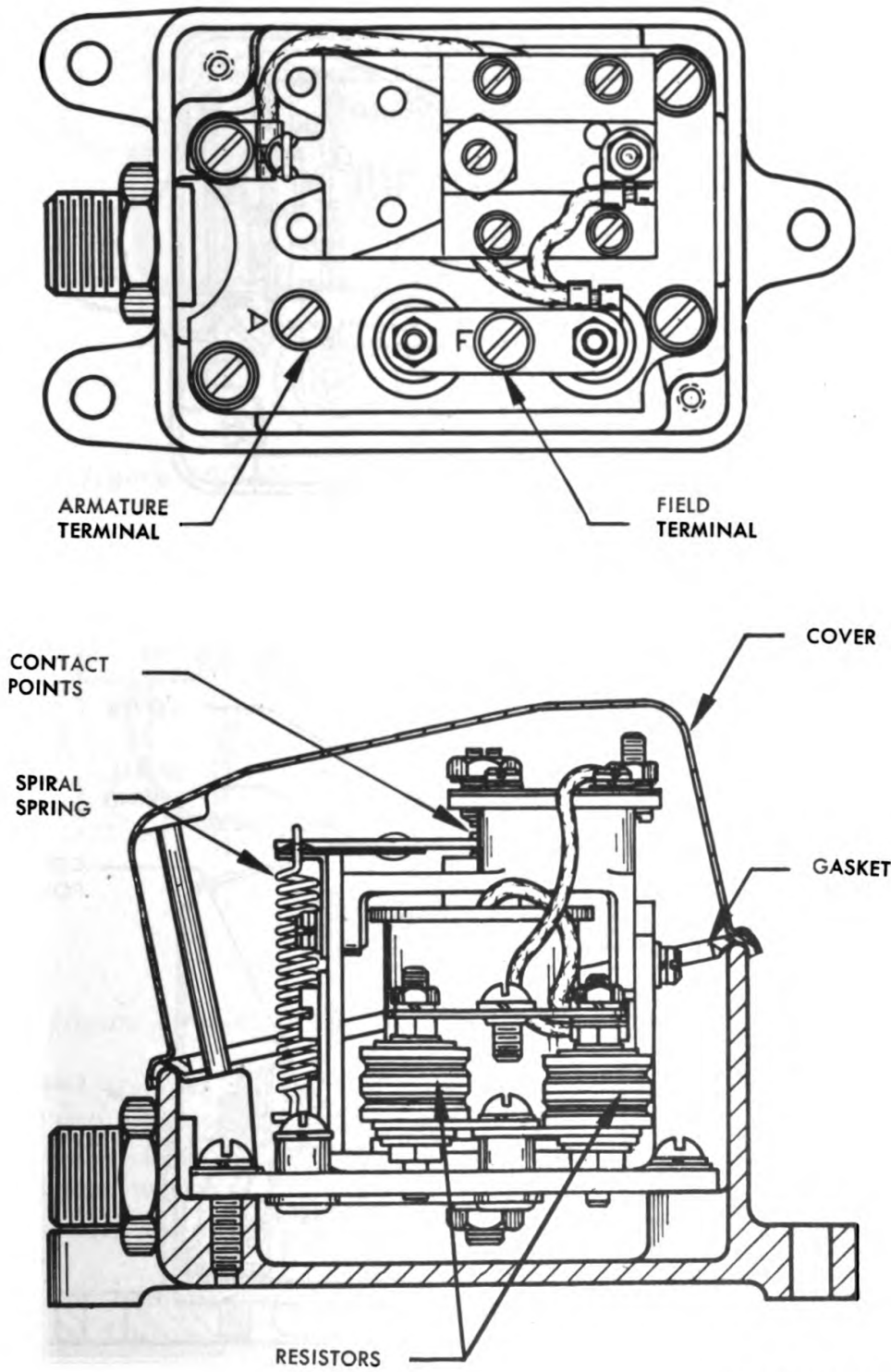


**Figure 99—Voltage Regulator Used with Type Two,
Third-brush Generators**

(4) Disconnect heavy relay and regulator leads by removing in order named, lead clamping screw, lock washer and flat washer, and then unsoldering the two leads.

(5) Remove voltage regulator from fiber mounting plate by removing nut and lock washer from stud on under side of plate.

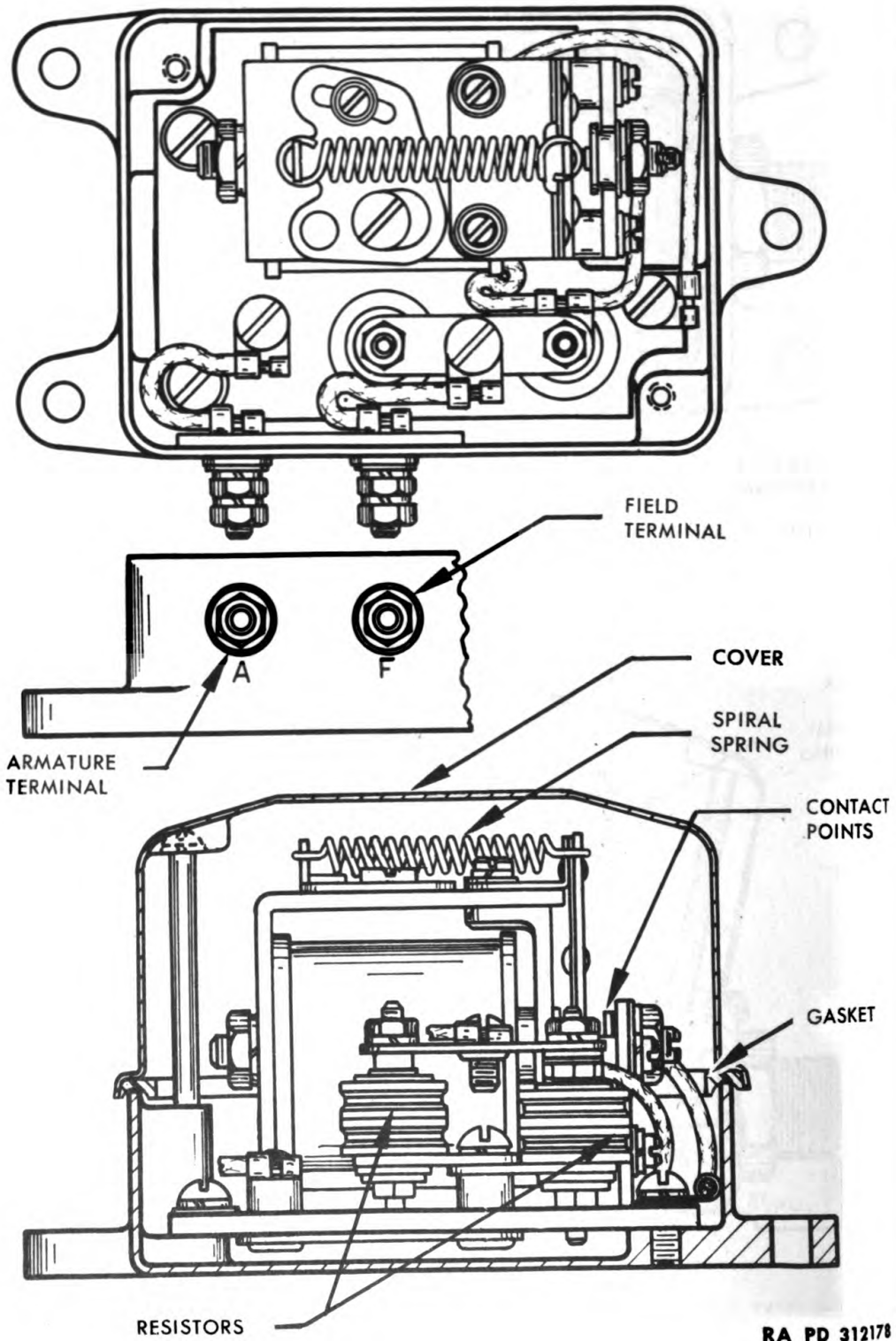
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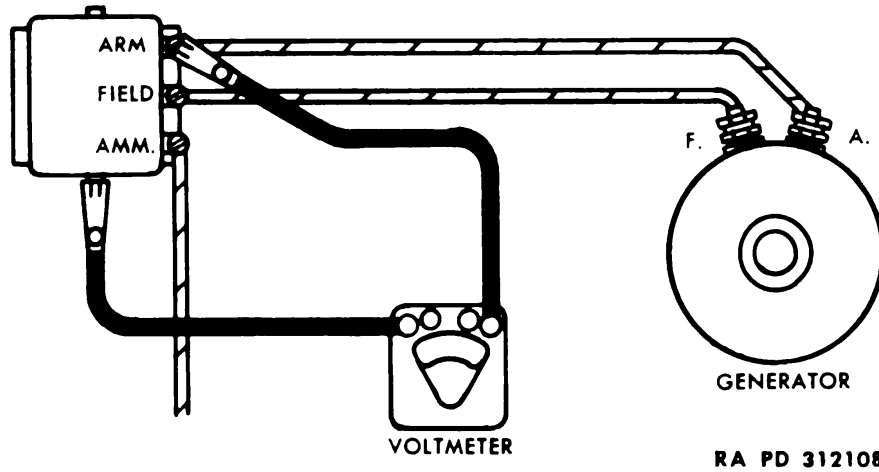
Figure 100—Voltage Regulator Unit Used with Auxiliary Engine Generator

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ELECTRICAL EQUIPMENT (DELCO-REMY)**



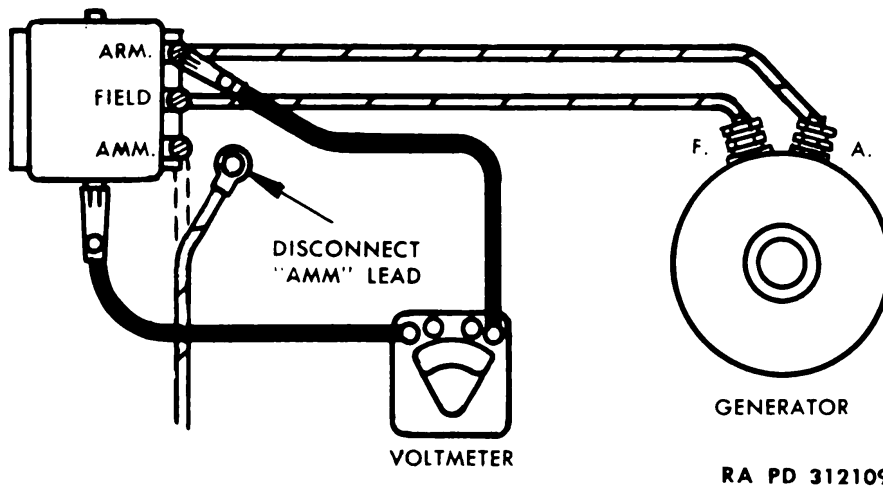
**Figure 101—Voltage Regulator Unit Similar to Unit Shown
in Figure 100 Except for Mounting**

GROUP V—VOLTAGE REGULATORS FOR TYPE TWO GENERATORS



RA PD 312108

Figure 102—Meter Connections to Test Cut-out Relay



RA PD 312109

Figure 103—Meter Connections to Test Voltage Regulator

(6) Remove cut-out relay from fiber mounting plate by removing nut and lock washer from stud on under side of plate.

(7) Disconnect lead from resistance assembly by removing nut and lock washer.

b. Disassembly Into Main Subassemblies (type shown in fig. 106).

(1) Remove cover by unscrewing two cover screws.

(2) Disconnect lead from regulator contact bracket by removing nut and lock washer.

(3) Take connector strap between two resistors off by removing two nuts and lock washers. This also disconnects leads from one resistor.

(4) Remove resistors by taking out attaching screw and lock washer

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ELECTRICAL EQUIPMENT (DELCO-REMY)**

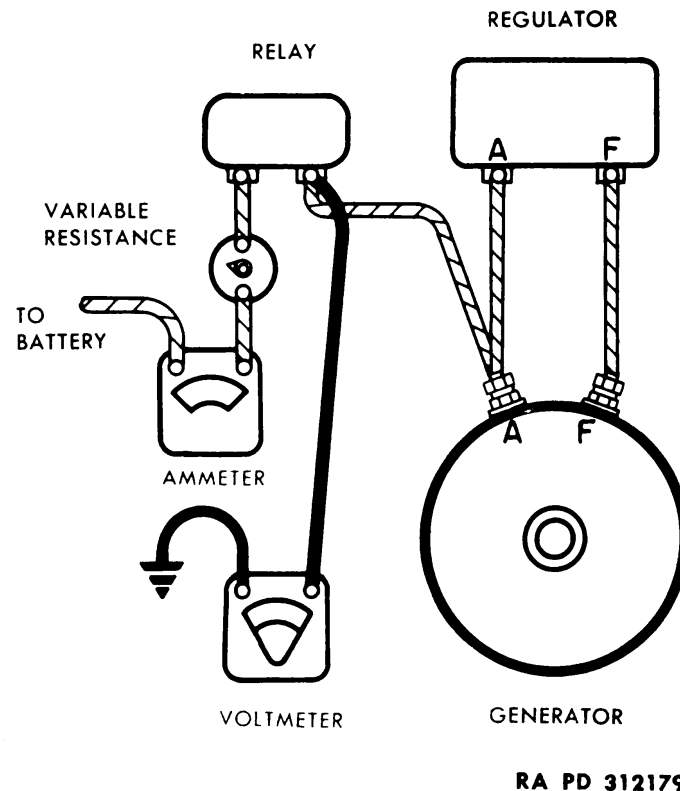
(5) Detach fiber mounting plate, with regulator unit, from base by taking out four screws, lock washers, and plain washers. This disconnects lead that goes to regulator winding.

(6) Take regulator unit off plate by unscrewing nut and lock washer.

c. **Disassembly Into Main Subassemblies** (type shown in fig. 107).

(1) Remove cover by unscrewing two cover screws.

(2) Take connector strap between two resistors off by removing screw connecting lead to it and removing two nuts and lock washers. This also disconnects leads from one resistor.



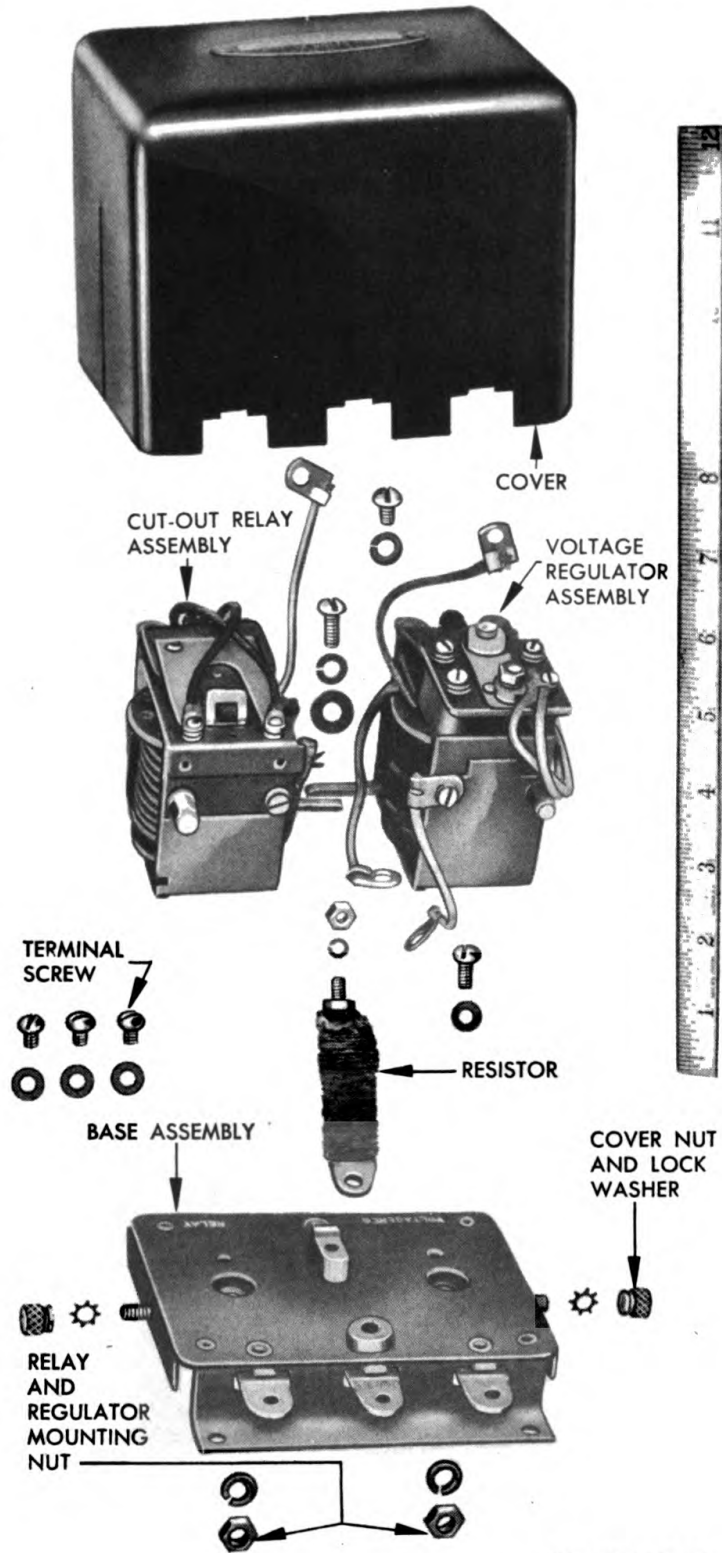
**Figure 104—Meter Connections to Test Voltage Regulator
Shown in Figures 100 and 101**

(3) Remove resistor by taking out attaching screw and lock washer.

(4) Disconnect lead from terminal on mounting plate by removing screw and lock washer.

(5) Detach mounting plate, with regulator unit, from base by taking out three screws, lock washers, and plain washers. This also disconnects lead that goes to regulator winding.

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RA PD 312110

Figure 105—Disassembled View of Regulator Shown in Figure 99

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ELECTRICAL EQUIPMENT (DELCO-REMY)

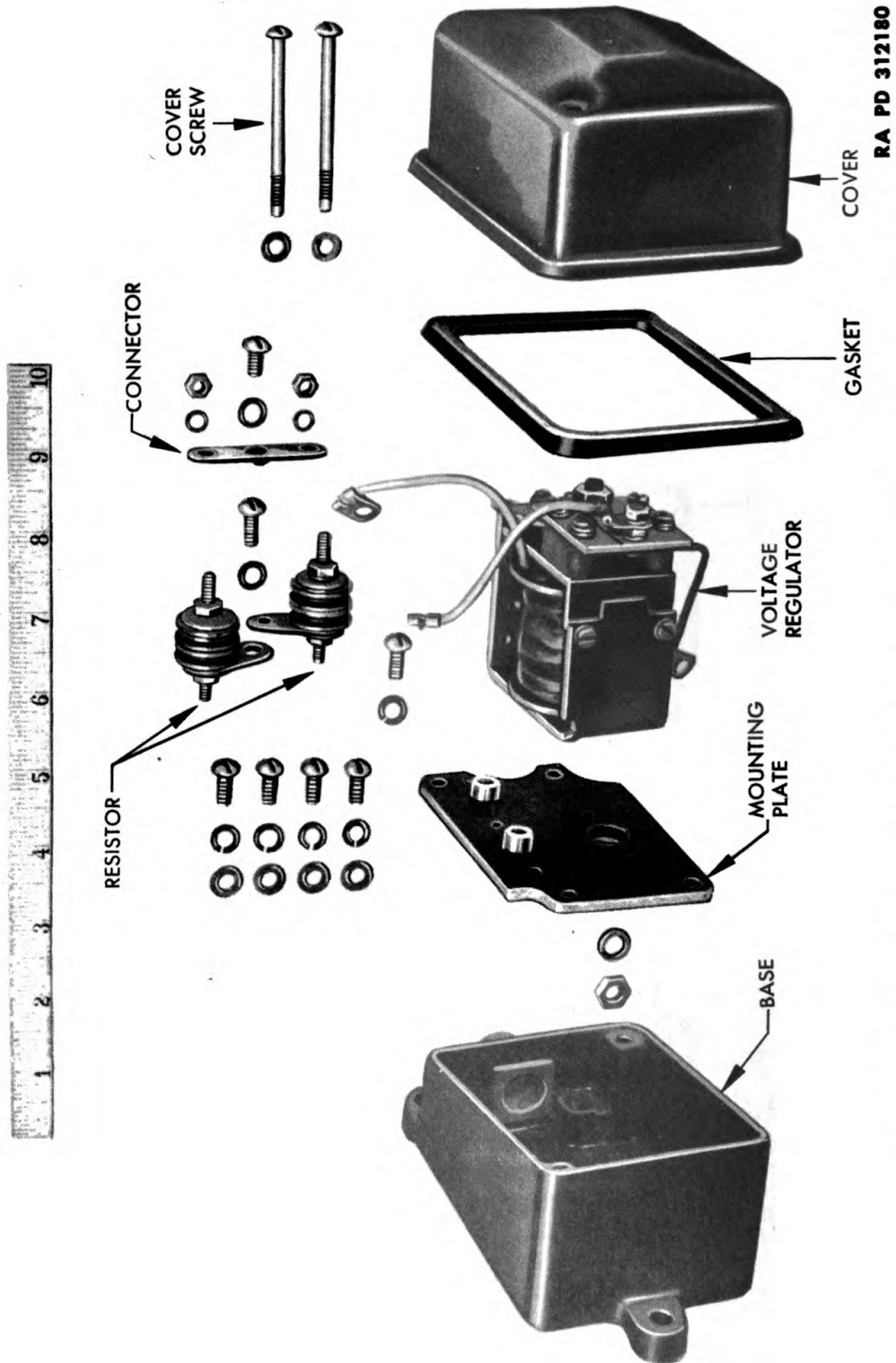


Figure 106—Disassembled View of Regulator Shown in Figure 100

GROUP V—VOLTAGE REGULATORS FOR TYPE TWO GENERATORS

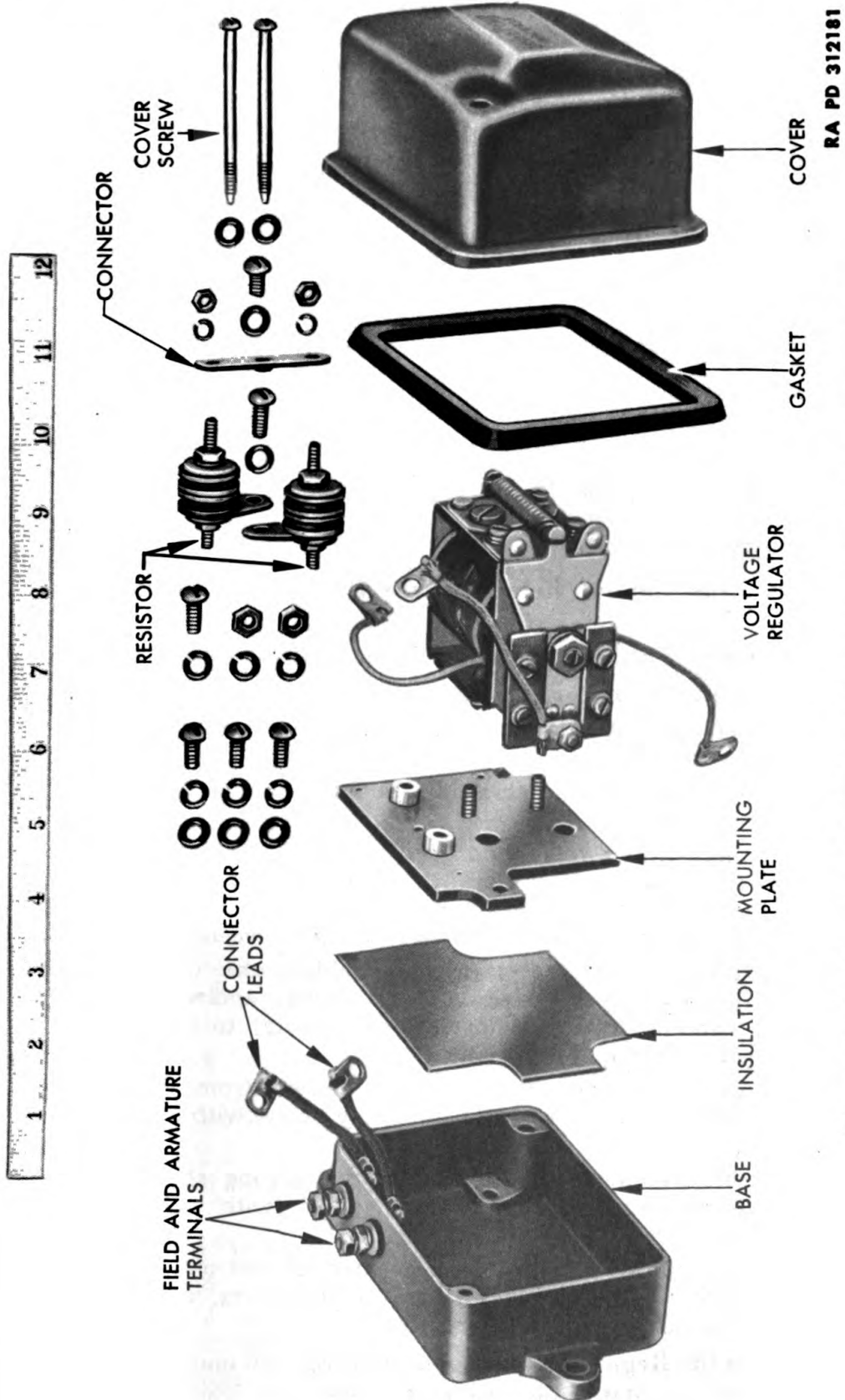


Figure 107—Disassembled View of Regulator Shown in Figure 101

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

(6) Detach regulator unit from mounting plate by unscrewing two nuts and lock washers from two attaching screws. Attaching screws are soldered to strap on plate, and must not be removed.

(7) Remove insulating paper from bottom of base and take off terminal screws, fiber insulator, and leads by removing nuts, lock washers, and washers. Do not remove insulators. The insulators are held in place by Glyptol, No. 1201, red.

d. **Disassemble Voltage Regulator.** Refer to paragraph 73 b.

e. **Disassemble Cut-out Relay.** Refer to paragraph 73 d.

82. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 74.

83. REPAIR OF PARTS.

a. Refer to paragraph 75.

84. ASSEMBLY.

a. **Assemble Cut-out Relay, Where Used.** Refer to paragraph 76 a.

b. **Assemble Voltage Regulator.** Refer to paragraph 76 c.

c. **Assemble Regulator** (type shown in fig. 105).

(1) Fasten cut-out relay to fiber mounting plate with nut and lock washer on stud.

(2) Fasten voltage regulator unit to fiber mounting plate with nut and lock washer on stud.

(3) Connect heavy relay and regulator leads as follows: Place heavy leads in place in lead clamp in fiber mounting plate between the relay and regulator unit. Solder the connections securely, using a rosin flux and secure with large washer, lock washer and screw.

(4) Install screw and lock washer holding the cut-out relay shunt winding lead (yellow insulation covering) and voltage regulator main winding lead (red insulation covering) to the grounded terminal on the fiber mounting plate.

(5) Connect resistance unit to clip of lead from the voltage regulator contact bracket support mounting screw with lock washer and nut.

(6) Install the lock washer and screw holding the resistance unit and voltage regulator series winding lead (with yellow insulation) to base.

(7) Solder spiral springs to armatures of cut-out relay and voltage regulator. This holds springs on armatures, and prevents possibility of their coming off in service.

d. **Assemble Regulator** (type shown in figs. 106 and 100).

(1) Attach regulator unit to plate with lock washer and nut.

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(2) Attach mounting plate, with regulator unit, to base with four screws, lock washers, and plain washers. Lead from regulator winding connects under one screw, between lock washer and plain washer (fig. 100).

(3) Attach resistors with screw and lock washer. Right-hand resistor (fig. 100) must go on first.

(4) Attach connector strap between two resistors with two nuts and lock washers. Two leads connect to right-hand resistor (fig. 100) before strap is put in place.

(5) Connect lead to regulator contact bracket with lock washer and nut.

(6) All leads must now be connected and located as shown in figure 100.

(7) Replace cover with two washers and cover screws. Rubber gasket must seat and seal all the way around.

e. Assemble Regulator (type shown in figs. 107 and 101).

(1) If two small terminal insulators in base have been removed, install new ones along with the terminal screws, inside fiber insulator, leads, plain washers, lock washers, and nuts. Paint around insulators with Glyptol No. 1201, red.

(2) Place insulating paper in bottom of base.

(3) If two screws in mounting plate have been removed, they must be soldered in place after the regulator unit is attached to plate with screws, lock washers, and nuts. Coat solder with Glyptol No. 1201, red.

(4) Attach mounting plate, with regulator unit, to base with three screws, lock washers, and plain washers. This also connects lead from regulator winding (fig. 101).

(5) Connect lead to terminal on mounting plate (fig. 101).

(6) Attach resistors with screw and lock washer. Right-hand resistor goes on first (fig. 101).

(7) Attach connector strap between two resistors with nuts and lock washers after first connecting two leads to right-hand resistor (fig. 101).

(8) Connect lead to connector strap with screw and lock washer (fig. 101).

(9) All leads must now be connected as shown in figure 101.

(10) Attach cover with washers and screws. Rubber gasket must seat and seal all way around.

85. TESTS AND ADJUSTMENTS.

a. Tests and adjustments are divided into two parts, mechanical and electrical. Electrical tests have been outlined (par. 80 c). Mechanical tests are outlined below.

b. Cut-out relay is checked and adjusted as outlined in paragraph

77 b.

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e. Voltage regulator is checked and adjusted as outlined in paragraph 77 e, if of type illustrated in figure 99. If of the type illustrated in figures 100 or 101, test on closed circuit with 10 amperes flowing (fig. 104); after each voltage adjustment readjust variable resistance to maintain 10 ampere output.

86. SPECIFICATIONS.

a. Group V Regulators—Voltage Regulators for Use with Type Two Generators.

Voltage Regulator Point Opening.....	0.015 inch
Cut-out Relay Air Gap.....	0.057 inch
Cut-out Relay Point Opening.....	0.020 inch

Model	VOLTAGE REGULATOR		Cut-out Relay Points Close (Volts)
	Voltage Setting (Open Circuit) 135°-145° F	Generator rpm for Voltage Setting	
5535 P #	15.0	1500	13.5
5536 P #	15.0	1500	13.5
5538 P #	8.5	2000	7.0
5570 P #	8.5	2000	7.0
5573 N #	15.0	1500	13.5
1118479 N #	*	2500	—
1118493 N #	*	2500	—

N—Negative.

P—Positive.

*—Voltage Regulator unit only. Set on closed circuit at 14.7 volts with 10 amperes current and generator operating at 2,500 rpm.

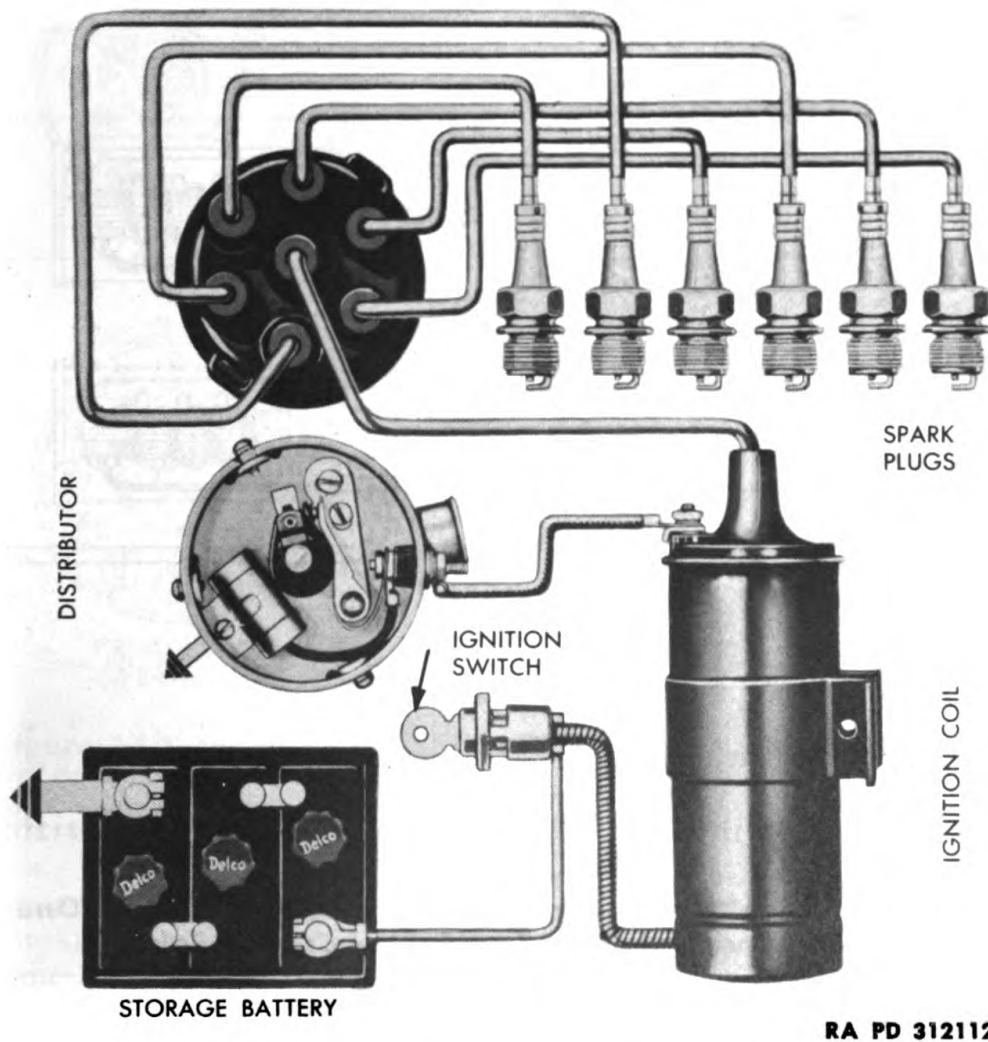
#CAUTION: *These regulators are designed for operation with a particular polarity system. Using a regulator which is designed for operation on a positive grounded system with a battery which has the negative terminal grounded will quickly destroy the regulator*

CHAPTER 4 DISTRIBUTORS

Section I

BASIC PRINCIPLES OF OPERATION

	Paragraph
Construction and function	87
Circuits	88
Types of distributors	89



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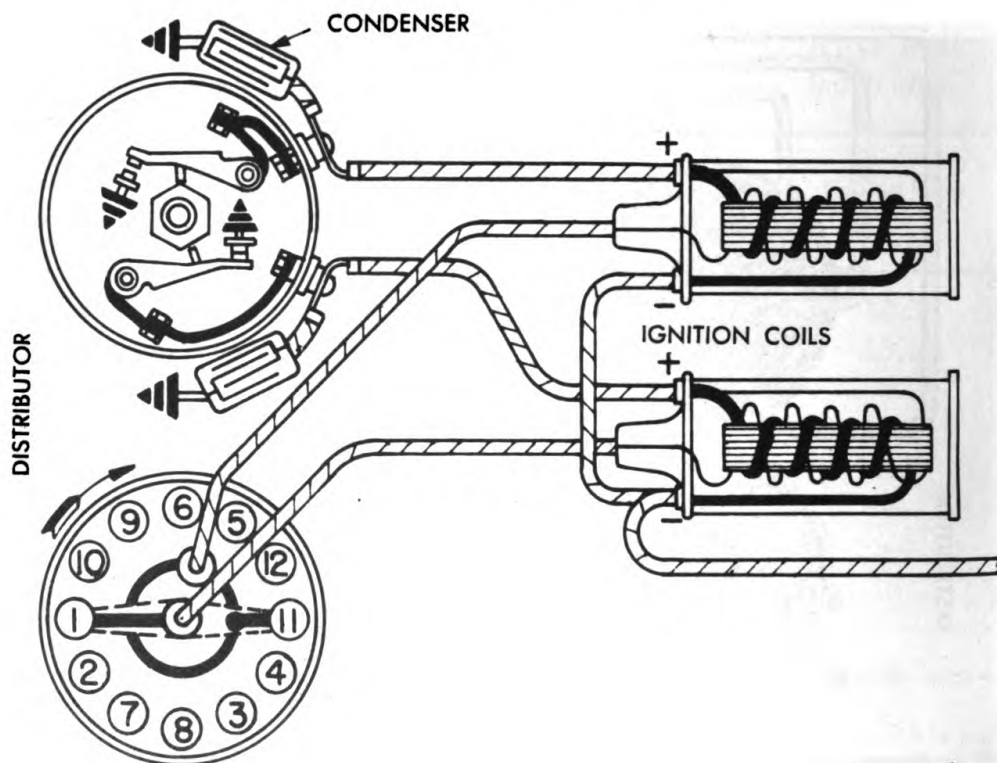
Figure 108—Ignition System Wiring Circuit

87. CONSTRUCTION AND FUNCTION.

a. The distributor contains a set of contact points with a breaker cam arranged to open and close the points, together with a driving arrangement to rotate the cam. The closing and opening of the

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contact points intermittently supplies current from the battery to the ignition coil so that the coil produces high voltage surges. These high voltage surges are delivered to the center terminal of the distributor cap, and from there they flow through the distributor rotor to the various outside cap terminals which are connected to the cylinder spark plugs. The distributor contains a centrifugal advance mechanism which advances the spark with engine speed. Figure 108 illustrates a typical ignition system which includes the battery, ignition switch, distributor, coil, spark plugs, and wiring.



FIRING ORDER
1-4-9-8-5-2-11-10-3-6-7-12

RA PD 312113

Figure 109—Ignition System for 12-Cylinder Engine with One Distributor Containing Two Sets of Contact Points

88. CIRCUITS.

a. The distributor contains either one or two sets of contact points. Figure 108 illustrates a system in which the distributor contains one set of points. Where the distributor uses two sets, they must be connected independently to two ignition coils. The high voltage surges from the coils are taken through two semi-independent circuits in the cap and rotor to two banks of cylinders on the engine so that, on a 12-cylinder engine, for example, one set of points and

BASIC PRINCIPLES OF OPERATION

one coil would fire one bank of six cylinders, while the other set of points and coil would fire the other bank of six cylinders (fig. 109). The second arrangement provides dual ignition (fig. 110), and is used with engines having two spark plugs per cylinder. In this system, the two sets of points close and open together so that both spark plugs are simultaneously fired in a cylinder.

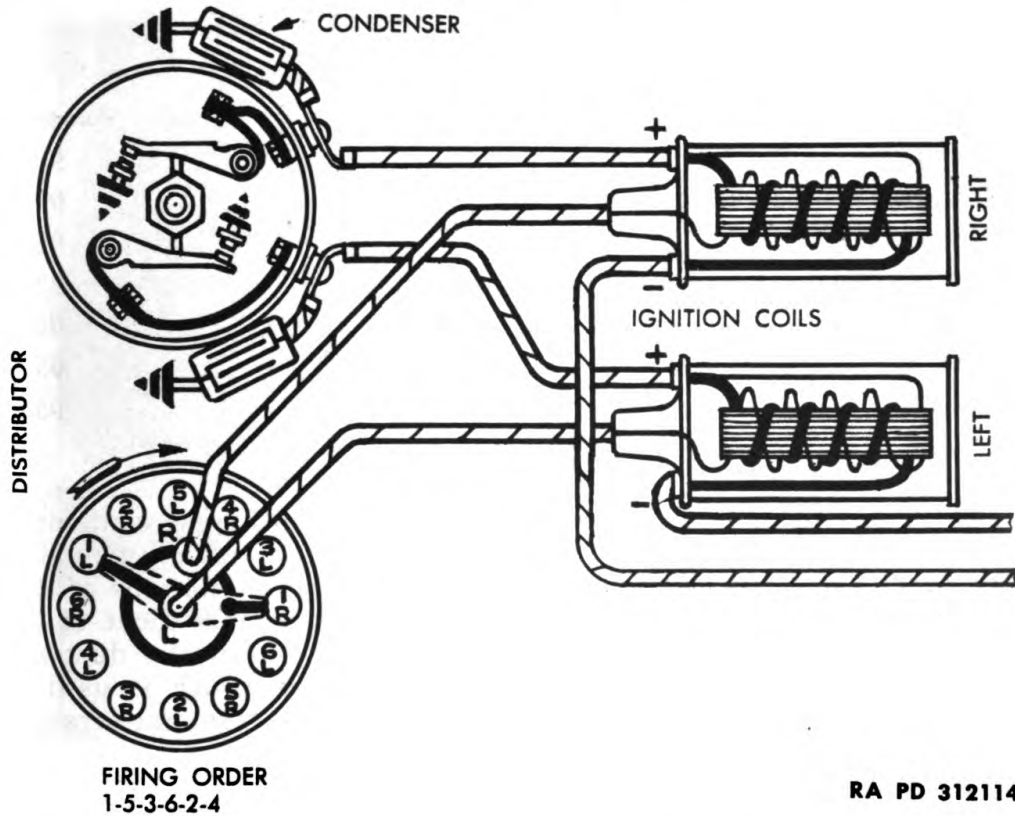


Figure 110—Ignition System for Dual Ignition 6-Cylinder Engine

89. TYPES OF DISTRIBUTORS.

a. In addition to various contact point and cap and rotor arrangements, some distributors are shielded for radio interference elimination, some have special drives for tachometers (fig. 116), some have special mounting arrangements (figs. 121 and 123).

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 4
DISTRIBUTORS (Cont'd)

Section II

GROUP I—SINGLE CONTACT SET,
STANDARD MOUNTING

	Paragraph
Description	90
Cleaning, inspection, and test	91
Disassembly	92
Cleaning, inspection, and test of parts	93
Assembly	94
Tests and adjustments	95
Test data and tolerances	96

90. DESCRIPTION.

a. Distributors in this group are of the standard type, containing one set of contact points and designed for standard mounting arrangements. Figures 111, 114, and 116 illustrate variations of distributors in this group. Note that the breaker compartment of the distributor in figure 114 is sealed off to prevent entrance of dust and the distributor in figure 116 has a special drive which is used to drive a tachometer. Figure 113 illustrates various terminal arrangements used on distributors.

91. CLEANING, INSPECTION, AND TEST.

a. **Cleaning.** Remove cap and rotor (and seal assembly if present), and wipe clean and dry with a clean cloth. Do not wash in cleaning compound since this will damage the insulating properties of the cap or rotor. Wipe distributor housing to remove dirt and grease. Blow out dust or dirt from inside of distributor with compressed air.

b. **Inspection.** Inspect cap and rotor for cracks, chipped places, or burned paths which would permit high tension leakage to ground. Discard any cracked, chipped or burned cap or rotor. Note condition of rotor spring or button and rotor insert. Discard rotor if spring is cracked or contact button is loose on spring. Discard rotor if insert is badly burned. Open contact points by hand, and inspect contact surfaces. If they are badly burned, pitted or rough, clean or replace and reset (par. 95). Inspect breaker arm rubbing block and bushing for wear and looseness. Replace if excessive wear or looseness is noted. Check shaft for freeness of rotation in housing. Excessive stiffness or looseness requires disassembly for further inspection, and possible replacement of parts. Inspect felt seal in seal

GROUP I—SINGLE CONTACT SET, STANDARD MOUNTING

assembly (where used). If felt seal is hard, worn, oily or dirty, replace it.

c. **Test.** Test condenser on condenser tester. Install distributor in distributor tester and make tests. Clean and adjust contact points

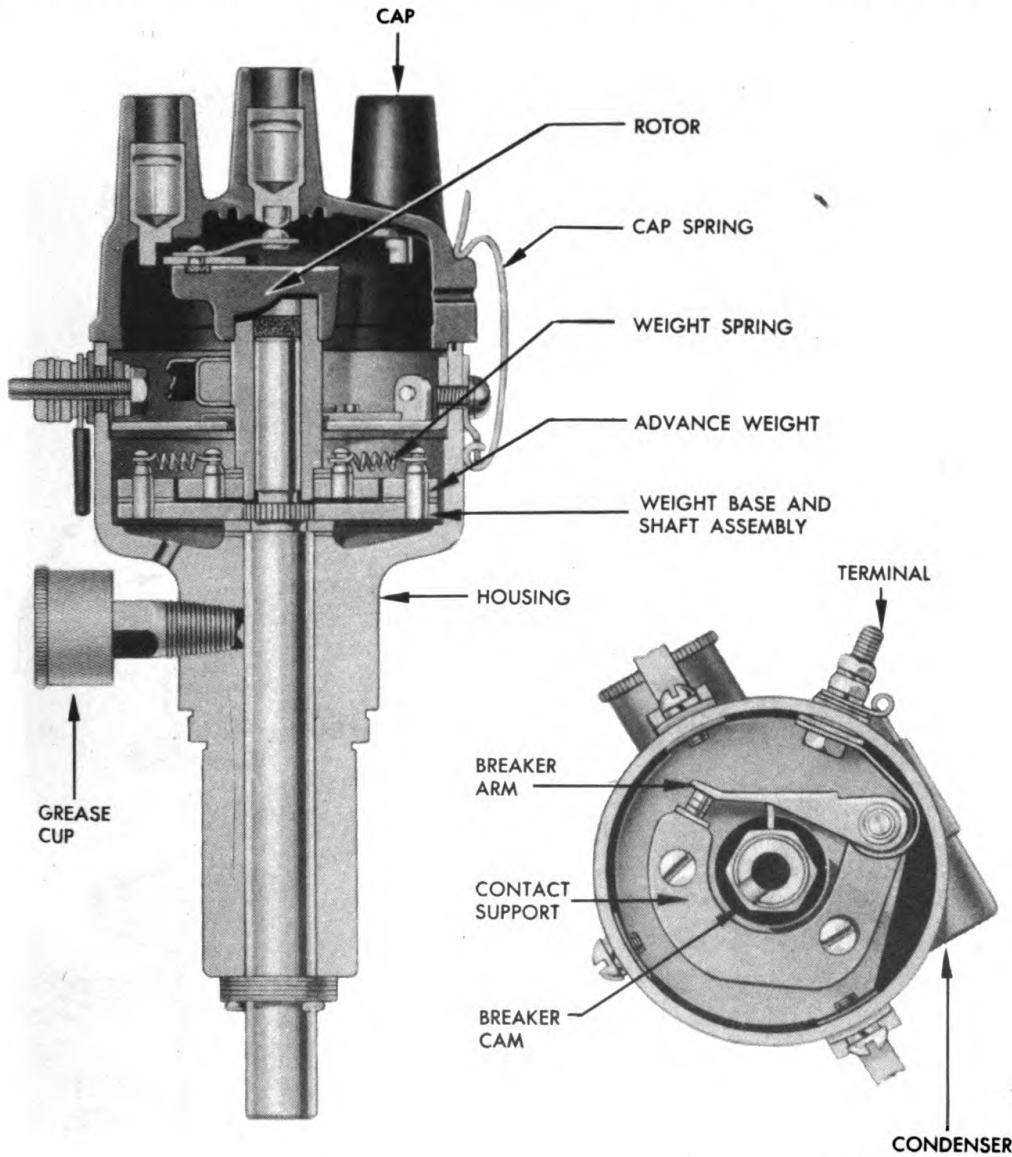


Figure 111—Sectional View of Standard Type Distributor

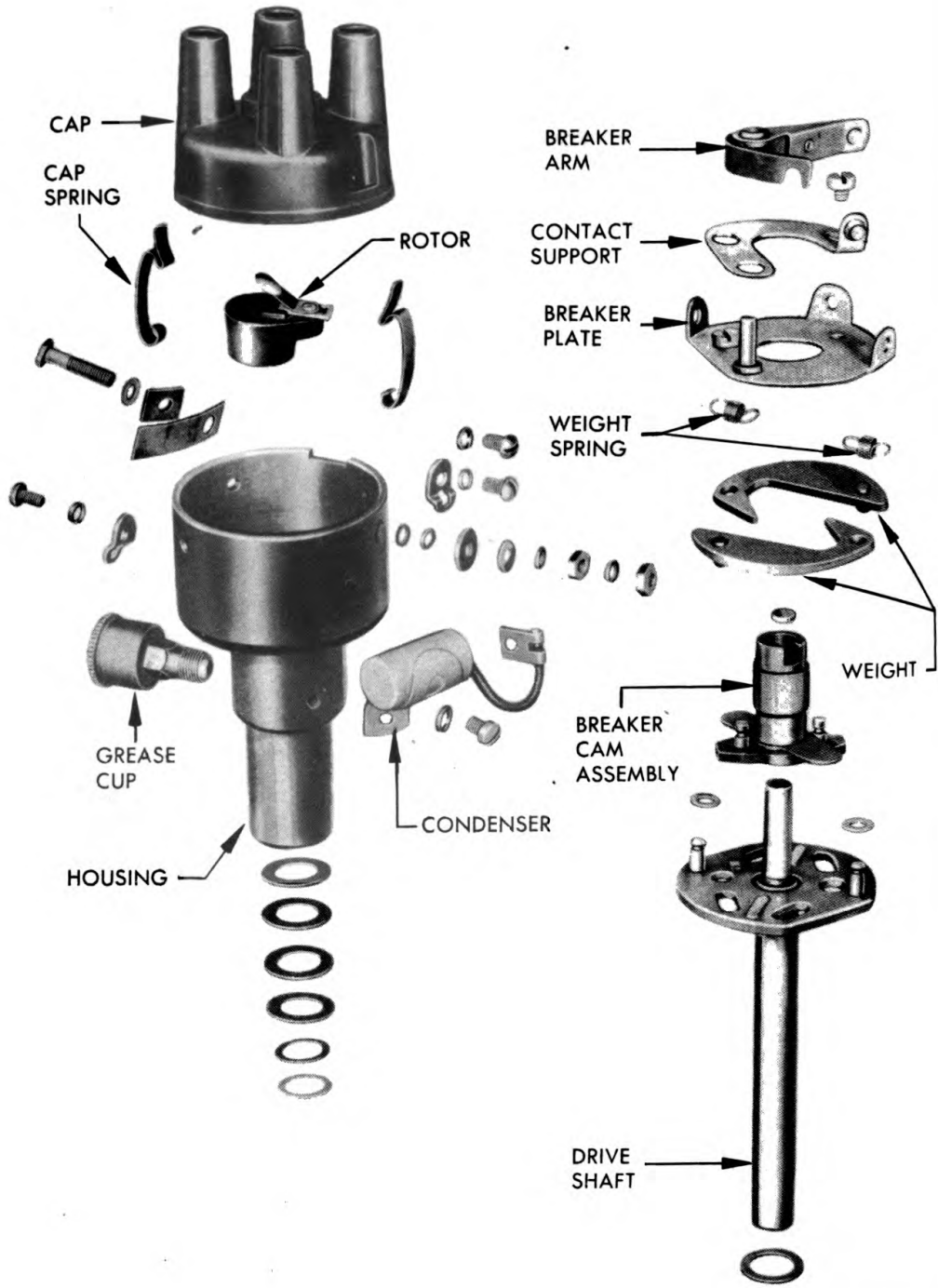
before making test. Clean dirty, pitted or rough contact points with a fine-cut contact file. File only enough to remove dirt from high spots; do not attempt to file smooth. Adjust contact points (par. 95).

92. DISASSEMBLY.

a. The disassembly procedure varies somewhat according to type of distributor. Follow general disassembly procedure outlined below

TM 9-1825A
92

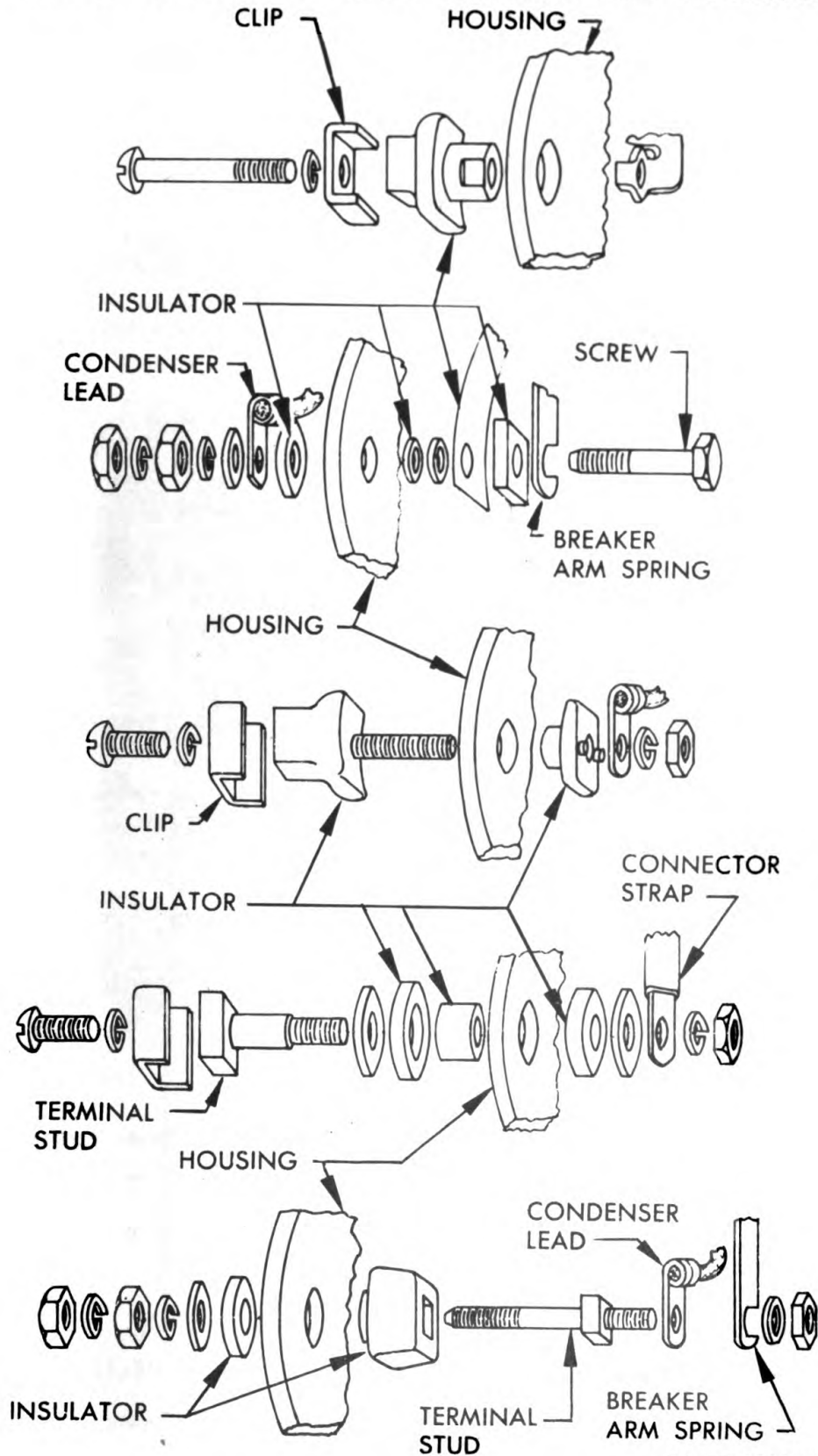
**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**



RA PD 312116

Figure 112—Standard Type Distributor, Disassembled

GROUP I—SINGLE CONTACT SET, STANDARD MOUNTING

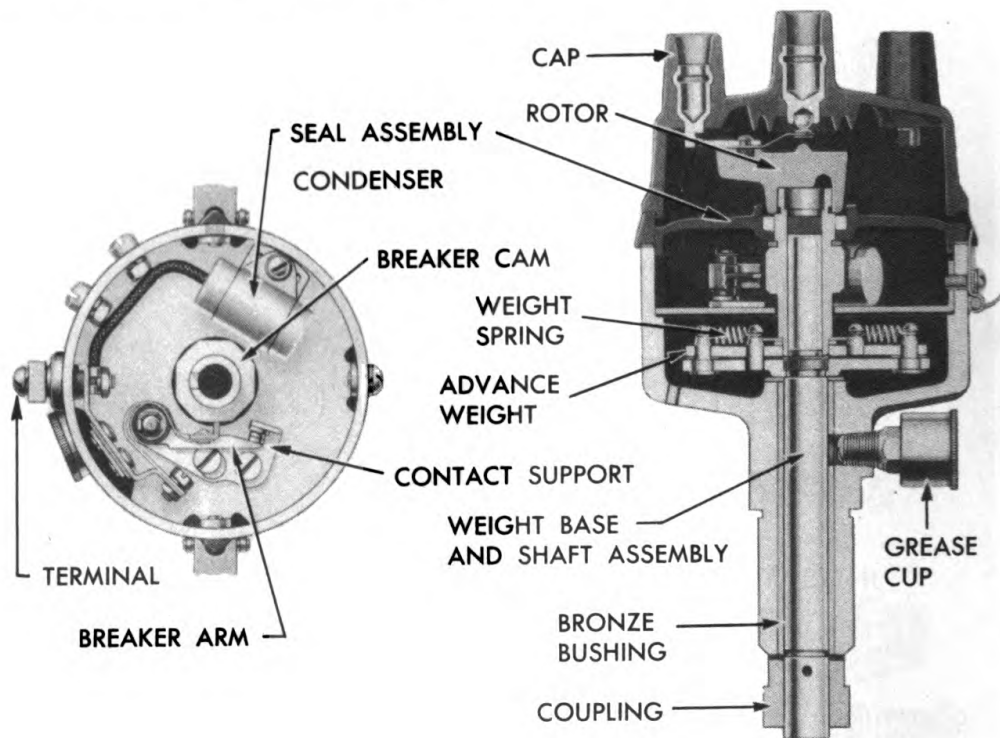


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and refer to illustration covering type of distributor being disassembled (figs. 111 through 116).

- b. Detach cap by unsnapping springs.
- c. Lift off rotor.
- d. Lift off seal assembly (where present).
- e. Lift off breaker arm by removing retainer clip (where present), loosening breaker arm spring attaching screw or nut, compressing breaker arm spring and lifting arm from hinge post.
- f. Detach stationary contact point support by unscrewing lock screw, and lifting off point support.



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**Figure 114—Sectional View of Standard Type Distributor
with Breaker Compartment Seal**

- g. Detach condenser by removing attaching screw and lead attaching screw or nut.
- h. Disassemble distributor terminal (fig. 113).
- i. Detach breaker plate by unscrewing attaching screws and lifting plate from housing. Where a filter is attached to housing, remove the filter first.
- j. Remove gear or coupling on drive shaft by driving out pin.
- k. Unscrew tachometer drive connection, where present, from shaft (fig. 116).

GROUP I—SINGLE CONTACT SET, STANDARD MOUNTING

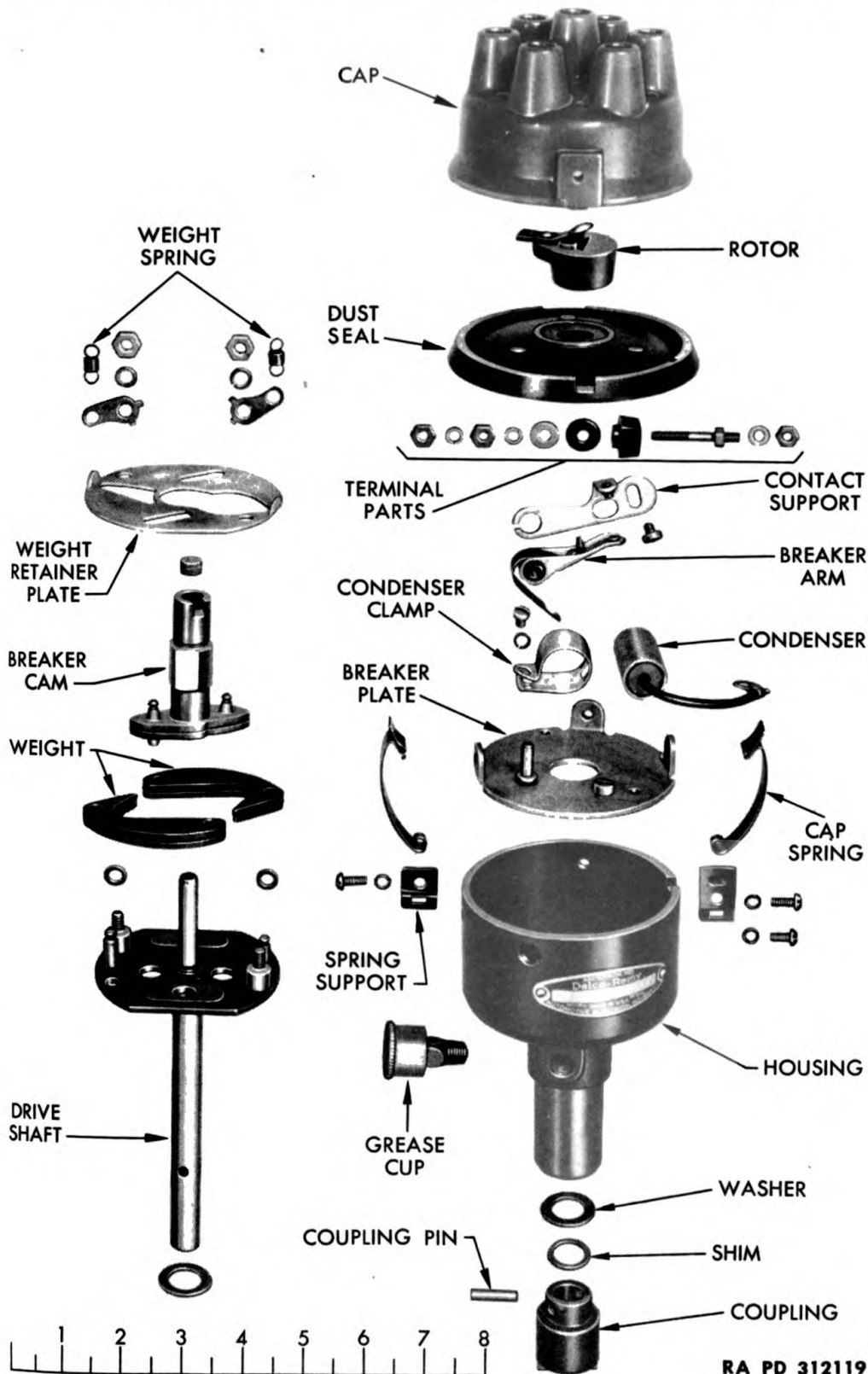
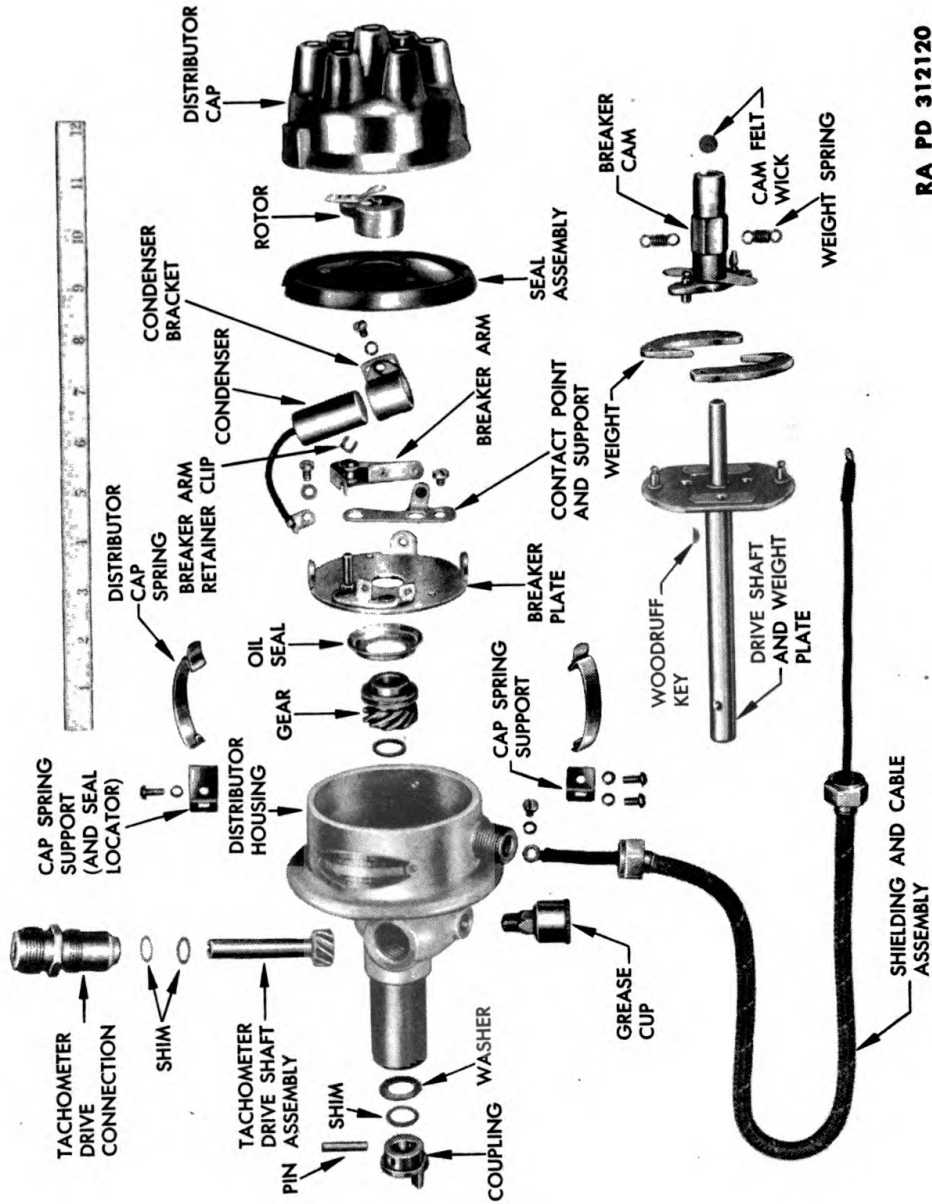


Figure 115—Standard Type Distributor with Breaker
Compartment Seal, Disassembled

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312120

Figure 116—Standard Type Distributor with Tachometer Drive, Disassembled

GROUP I—SINGLE CONTACT SET, STANDARD MOUNTING

- l. Separate weight base and shaft assembly from housing.
- m. On distributor with tachometer drive, take gear assembly and oil seal from housing.
- n. Disassemble centrifugal advance mechanism by taking off the advance springs, weights, and breaker cam assembly. Where the centrifugal advance mechanism is covered by a plate (fig. 115), remove the nuts, lock washers, and plate first.
- o. Where housing has replaceable bearing, examine bearing and press out for replacement, if it is worn.

93. CLEANING, INSPECTION, AND TEST OF PARTS.

a. **General.** Clean and examine all parts. Do not clean cap, rotor, condenser, and insulators in any degreasing compound. Examine centrifugal advance parts, weights, springs, and plate, for signs of wear. Studs must be tight in weights and weight base. Insulators, screws, washers, nuts, etc., must be in normal condition. Replace screws which are bent, battered, broken, or which have crossed threads. Replace insulators and washers that are cracked, bent, worn, burned, etc. Replace leads that have broken strands, or badly frayed insulation. Replace seal in seal assembly if it is hard, worn, or dirty. Replace cap or rotor if they are cracked, chipped, or burned. Replace contact points if they are badly burned or pitted, or if the breaker arm rubbing block or bushing is excessively worn or loose.

94. ASSEMBLY.

- a. The assembly procedure varies according to type of distributor. Follow the general assembly procedure outlined below, and refer to illustrations covering type of distributor being assembled (figs. 111 through 116).
- b. Press in new bearing if old bearing has been removed.
- c. Assemble centrifugal advance mechanism, installing plate where present. If lock washers are of type with tangs that are bent down against face of nut to lock nut, use new lock washers. On distributor with tachometer drive, place oil seal and gear assembly into housing.
- d. Insert weight base and shaft assembly into housing.
- e. Install gear or coupling, insert pin, and peen ends to secure it in place. Do not allow any part of pin to project far enough to interfere with the gear or coupling driving arrangement.
- f. Screw tachometer drive connection, where used, into housing.
- g. Attach breaker plate to housing. Install filter, where used.
- h. Assemble distributor terminal (fig. 113), leaving loose where breaker arm spring or condenser lead attaches to it.
- i. Attach condenser and condenser lead.

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ELECTRICAL EQUIPMENT (DELCO-REMY)**

j. Attach stationary contact support with lock screw, leaving loose for adjustment.

k. Install breaker arm, and secure with retainer clip (where present) and breaker arm spring attaching screw or nut.

l. Install seal assembly (where present), rotor, and cap after contact points have been adjusted (par. 95).

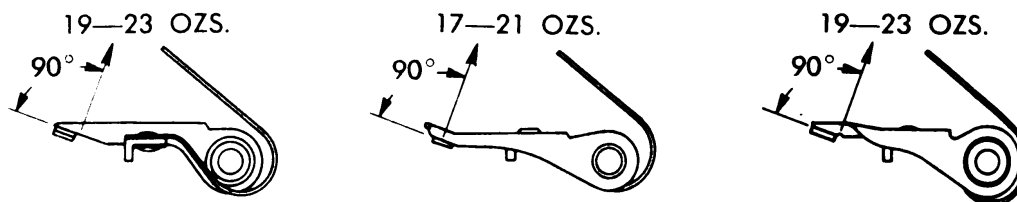
m. **Lubricate Distributor.** Apply one or two drops of engine oil, SAE 10 on the felt wick in the breaker cam under the rotor. Place a trace of general purpose grease, No. 0 on the breaker cam (using only a trace to avoid getting lubricant on contact points). Fill grease cup with general purpose grease, No. 2 and turn down one turn. Where high pressure fitting, or hinge cap oilers are used, lubricate through means provided.

95. TESTS AND ADJUSTMENTS.

a. Test distributor on distributor tester. Measure contact point pressure with a spring gage hooked on the breaker arm as close to the contact point as possible. Pull on arm in a direction vertical to the contact point face until points separate. Adjust by bending the breaker arm spring. Measure contact point opening, and adjust by loosening the lock screw and turning the eccentric. Tighten lock screw after adjustment is complete.

96. TEST DATA AND TOLERANCES.

a. **Explanation.** The cam angle is the angle of cam rotation through which the points remain closed. This angle is decreased with increased point opening, and increased with decreased point opening. Eccentricity and bearing wear will cause variations in the cam angle. The angle given below is subject to a plus or minus 2-degree variation because of the above conditions. A new breaker arm and rubbing block must be set with 3 degrees less cam angle than shown below. Angle shown below is based on a worn-in rubbing block. Figure 117 shows the proper spring tension for the various types of circuit breaker levers and the positions on the levers where the readings must be taken. NOTE: *Point opening is 0.018-0.024 inch unless otherwise indicated.*



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Figure 117—Spring Tensions of Breaker Arms

GROUP I—SINGLE CONTACT SET, STANDARD MOUNTING

TABLE OF TOLERANCES

Model	Rotation	Cam Angle Deg	Start Advance		Intermediate Advance		Maximum Advance		Tolerances
			RPM Eng	Deg Eng	RPM Eng	Deg Eng	RPM Eng	Deg Eng	
622-D	CC	35	600	2.0	—	—	2200	16.0	a
623-H	C	35	600	1.0	1200	9.0	2200	17.0	a
640-Z	CC	35	600	1.0	—	—	2000	20.0	b
642-S	CC	35	600	2.0	—	—	2200	16.0	b
649-C	CC	35	400	1.0	—	—	1800	27.5	a
649-E	CC	35	600	3.0	1800	15.5	2200	17.0	b
4156	CC	37	500	3.0	800	14.0	3200	34.0	b ¹
1110008	CC	35	600	1.75	—	—	3600	50.0	a
1110025	C	35	400	2.0	—	—	2200	18.5	c ¹
1110030	CC	35	600	2.0	1400	14.5	2300	26.0	d ¹
1110031	CC	35	500	3.0	800	14.0	3200	34.0	d ¹
1110032	CC	35	500	3.0	800	14.0	3200	34.0	d ¹
1110034	C	35	600	2.0	—	—	2200	22.0	c
1110039	CC	35	600	2.0	—	—	2600	20.0	c ¹
1110052	CC	35	800	4.0	1200	11.0	3100	37.0	e
1110054	C	35			No Advance				c ¹
1110057	C	35	600	2.0	—	—	2200	22.0	c
1110059	CC	35	500	3.0	800	14.0	3200	34.0	d ¹
1110062	CC	33	800	4.0	1200	11.0	3100	37.0	d ¹
1110070	CC	35	400	2.0	1000	14.0	1600	20.0	b
1110075	CC	35	400	2.0	800	10.0	3400	32.0	a
1110081	CC	35			No Advance				b
1110086	CC	35	600	2.0	—	—	2600	20.0	c
					1200	13.0			
1110090*	CC	38	600	1.0	2000	20.0	3450	39.5	e
1110095	C	35	600	2.0	1600	12.0	2600	18.0	a
1110098	CC	35	400	2.0	800	14.0	1800	24.0	a ¹
1110100	CC	35	400	2.0	800	10.0	3400	32.0	d
1110104	CC	35	600	3.0	1200	11.5	3000	28.0	c
1110106	CC	35	600	1.0	1200	13.0	3450	39.5	d ¹
					2000	20.0			
					1200	13.0			
1110110*	CC	38	600	1.0	2000	20.0	3450	39.5	d ¹
					1200	13.0			
1110111*	CC	38	600	1.0	2000	20.0	3450	39.5	a
1110112	CC	35	600	2.0	—	—	2800	22.0	c ¹
1110113	C	35	600	2.0	1600	12.0	2600	18.0	f
1110114	C	35	400	2.0	800	8.0	2400	22.0	a ¹
1110115	C	35	400	2.0	—	—	2200	18.5	c ¹
1110120	CC	35	400	2.0	800	10.0	3400	32.0	e
1110123	C	35	600	2.0	—	—	2200	17.0	c
1110125	CC	35	700	2.0	1000	8.0	2600	24.0	a
1110133	CC	35	400	2.0	1000	14.0	1600	20.0	b
1110134	CC	35	600	2.0	2400	12.0	3000	14.0	b
1110135	CC	35	400	2.0	800	10.0	3400	32.0	e
					1200	13.0			
1110136*	CC	38	600	1.0	2000	20.0	3450	39.5	e
1110137	CC	35	400	2.0	—	—	2000	32.0	c
1110143	C	35	400	1.0	—	—	1400	22.0	c ¹
					1200	13.0			
1110148*	CC	38	600	1.0	2000	20.0	3450	39.5	a
					1200	13.0			

For explanatory footnotes see page 164.

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

TABLE OF TOLERANCES (Cont'd)

Model	Rotation	Cam Angle Deg	Start Advance		Intermediate Advance		Maximum Advance		Toler- ances
			RPM Eng	Deg Eng	RPM Eng	Deg Eng	RPM Eng	Deg Eng	
1110149	CC	38	600	1.0	2000	20.0	3450	39.5	e
1110150	C	35	600	2.0	1600	12.0	2600	18.0	f
1110151	CC	35	400	2.0	1000	14.0	1600	20.0	b
1110152	C	33	—	—	—	—	—	—	d
					800	4.0			
1110153	CC	35	400	2.0	1200	9.0	2000	14.0	c
1110156	CC	35	500	4.0	750	8.0	3400	32.0	e
1110157	C	35	400	2.0	—	—	2200	18.5	c ¹
1110158	CC	35	500	3.0	800	14.0	3200	34.0	g ¹
1110159	CC	35	600	2.0	—	—	2800	22.0	h ¹
1110160	C	35	600	2.0	1600	12.0	2600	18.0	f
1110161	CC	35	300	0.5	1000	14.5	1800	22.5	b
1110162	CC	35	400	2.0	—	—	2100	24.0	a ¹
1110163	CC	35	400	2.0	600	8.0	1200	37.0	a
1110165	CC	35	400	2.0	800	8.0	2400	22.0	c
1110167	CC	37	600	3.0	1200	11.5	3000	28.0	a
1110168	CC	36	500	3.0	800	14.0	3200	34.0	d ¹
1110169	CC	36	400	2.5	1800	22.5	2700	29.5	c
1110170	CC	36	600	2.0	900	14.0	3000	34.0	a ¹
1110172	CC	36	600	2.0	1000	13.0	2400	22.0	c
1110174	CC	36	600	2.0	—	—	2800	22.0	g ¹
1110175	CC	36	800	4.0	1200	11.0	3100	37.0	e
1110176	C	36	400	2.0	—	—	2800	18.0	b
1110177	C	36	500	4.0	—	—	2800	37.0	a ¹
1110417	CC	32	500	4.0	—	—	1200	18.0	a
1110418	C	33	550	3.0	1600	18.5	2400	25.0	a ¹
					2000	23.0			
1110507	CC	35	800	2.0	2400	11.5	2800	12.0	a
1110609*	CC	31	1000	1.0	—	—	4000	24.0	b ¹
1110810	CC	31	1000	1.0	—	—	4000	24.0	b ¹
1111506	C	35	500	3.0	—	—	1250	27.0	d

* Point Opening 0.015–0.021 inch.

¹ Bronze Bearing.

- a Housing I.D. 0.4905–0.4915 Shaft O.D. 0.4895–0.4900
- b Housing I.D. 0.5000–0.5005 Shaft O.D. 0.4993–0.4997
- c Housing I.D. 0.4903–0.4908 Shaft O.D. 0.4895–0.4900
- d Housing I.D. 0.4905–0.4910 Shaft O.D. 0.4895–0.4900
- e Housing I.D. 0.4903–0.4915 Shaft O.D. 0.4895–0.4900
- f Housing I.D. 0.4905–0.4915 Shaft O.D. 0.4893–0.4898
- g Housing I.D. 0.4905–0.4910 Shaft O.D. 0.4897–0.4900
- h Housing I.D. 0.4903–0.4908 Shaft O.D. 0.4897–0.4900

C Clockwise rotation viewing drive end.

CC Counterclockwise rotation viewing drive end.

CHAPTER 4
DISTRIBUTORS (Cont'd)

Section III

**GROUP II—DUAL CONTACT SET,
STANDARD MOUNTING**

	Paragraph
Description	97
Cleaning, inspection, and test	98
Disassembly	99
Cleaning, inspection, and test of parts	100
Assembly	101
Tests and adjustments	102
Test data and tolerances	103

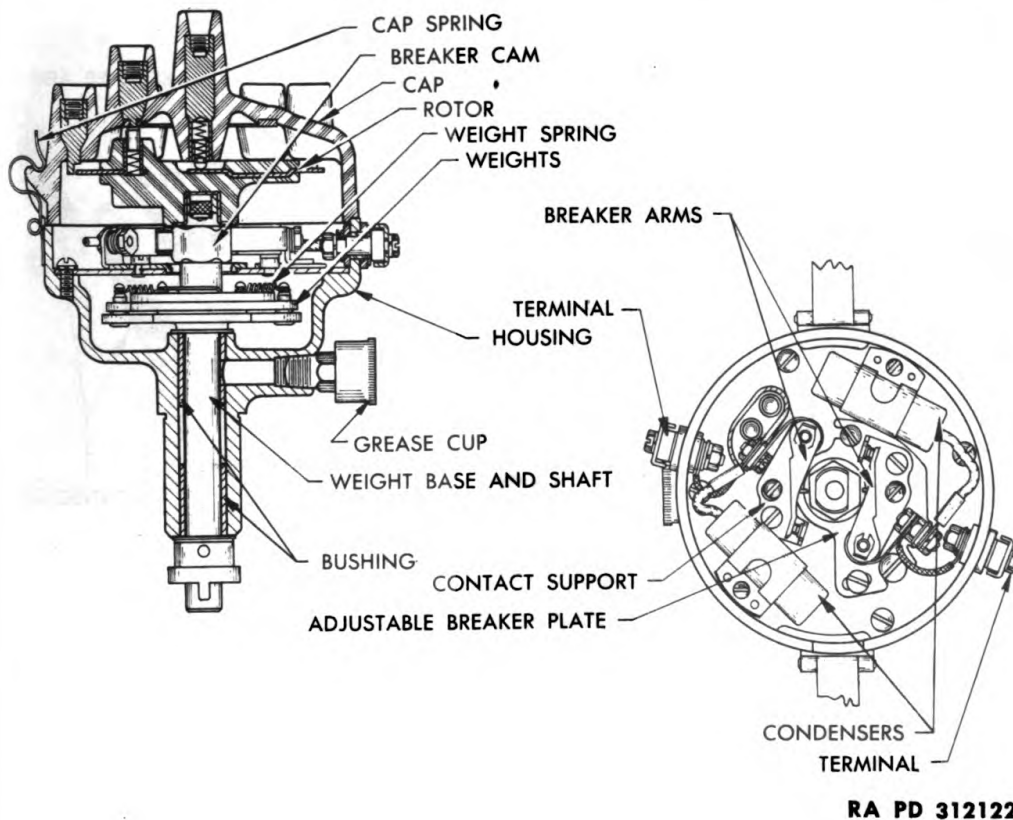


Figure 118—Sectional View of Distributor with Dual Contact Points and Standard Mounting

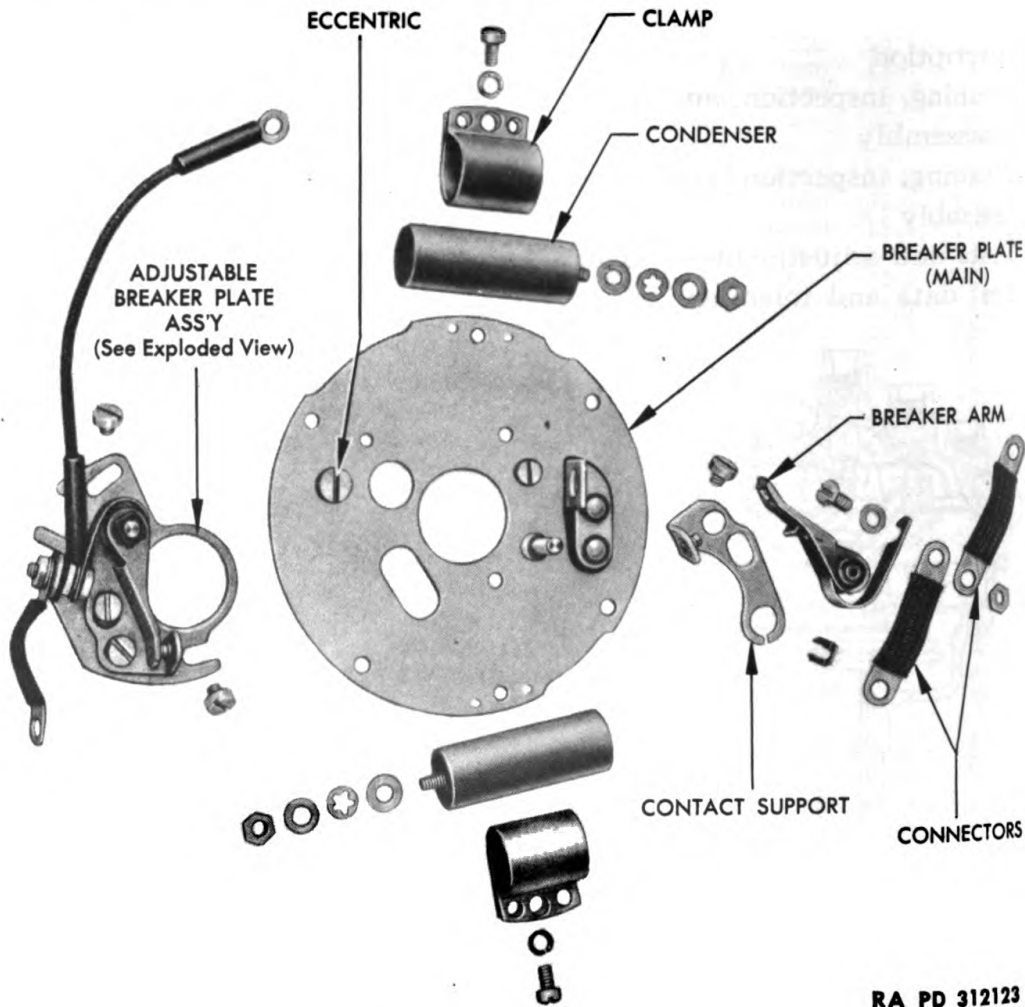
97. DESCRIPTION.

a. Distributors in this group are similar to Group I distributors except that they incorporate two sets of contact points (fig. 118) for use in dual ignition systems, or ignition systems using two ignition coils for firing two banks of the engine (figs. 109 and 110).

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98. CLEANING, INSPECTION, AND TEST,

- a. **Cleaning.** Refer to paragraph 91 a.
- b. **Inspection.** Refer to paragraph 91 b.
- c. **Test.** Refer to paragraphs 91 c and 102.



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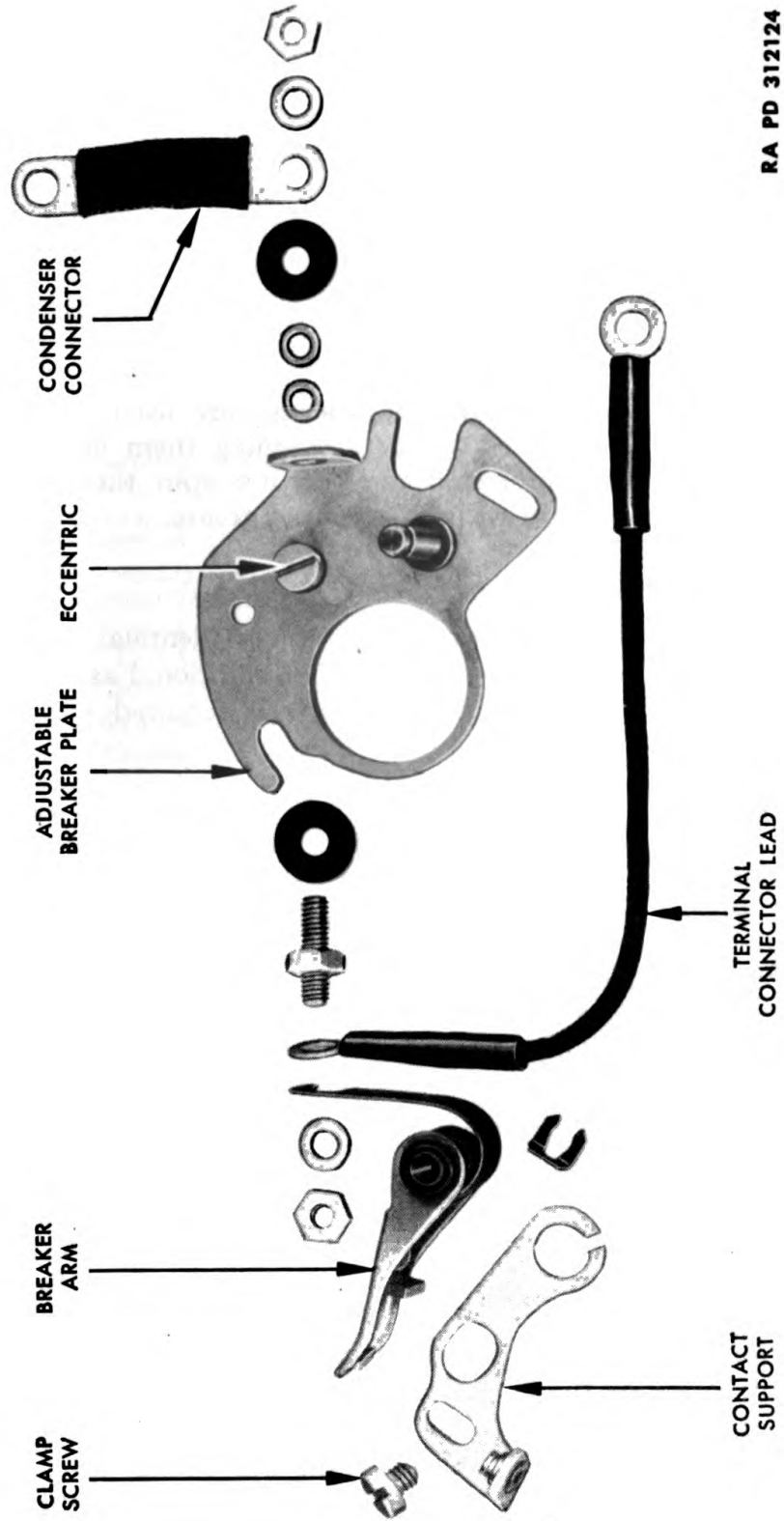
Figure 119—Stationary Breaker Plate with Two Sets of Contact Points, Disassembled

99. DISASSEMBLY.

a. The disassembly procedure is essentially identical to that for group I distributors (par. 92) except that there is additional disassembly required on the stationary and the adjustable breaker plates (figs. 119 and 120).

b. **Disassemble Circuit Breaker Plate.** Remove nuts, washers, and connectors from condensers. Detach condensers, connectors, stationary breaker arm and retainer clip, breaker arm spring screw, and breaker arm. Remove lock screw and lift off stationary contact

GROUP II—DUAL CONTACT SET, STANDARD MOUNTING



RA PD 312124

Figure 120—Adjustable Breaker Plate, Disassembled

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point. Remove two lock screws, and lift off adjustable breaker plate assembly.

c. Disassemble Adjustable Breaker Plate Assembly. Remove nut and lock washer holding breaker arm spring to stud. Slip off retainer clip, and remove breaker arm and lead from stud. Slip stud with insulators off. Unscrew lock screw, and detach stationary contact.

100. CLEANING, INSPECTION, AND TEST OF PARTS.

a. General. Refer to paragraph 93 a.

b. Ball Bearings. Where ball bearings are used, clean them if they are not of the sealed type by spinning them in dry-cleaning solvent. Dry with compressed air (do not spin them), and then promptly lubricate them with ball bearing grease.

101. ASSEMBLY.

a. The assembly procedure is essentially identical with that for group I distributors (par. 94) except that additional assembly of the stationary and adjustable breaker plates is required (figs. 119 and 120).

b. Assemble Adjustable Breaker Plate Assembly. Attach stationary contact with lock screw. Place stud in position and attach breaker arm with nut and lock washer. Be sure insulators are in place on stud. Place breaker arm retainer clip in position.

c. Assemble Circuit Breaker Plate. Attach adjustable breaker plate with lock screws. Attach stationary contact point with lock screw. Place breaker arm on pin and attach breaker arm spring with screw, along with connector. Place retainer clip above breaker arm. Attach condensers and connectors.

102. TESTS AND ADJUSTMENTS.

a. In addition to the tests and adjustments covered in paragraph 95, the two sets of contact points must be synchronized to open and close in the correct relation to each other. With the distributor in the distributor tester, note the synchronism of the two sets of points, and adjust by loosening the lock screws, holding the adjustable plate, and turning the eccentric. This moves the adjustable breaker plate with respect to the stationary contacts. Make this change after adjusting the contact point opening of both sets of points, and then recheck point opening after proper synchronism is obtained. Make further adjustment if necessary.

GROUP II—DUAL CONTACT SET, STANDARD MOUNTING

103. TEST DATA AND TOLERANCES.

Model	Rotation	Cam Angle Deg	Start Advance		Intermediate Advance		Maximum Advance		TOLERANCES	
			RPM Eng	Deg Eng	RPM Eng	Deg Eng	RPM Eng	Deg Eng	Lower Section	Upper Section
SM1310	CC	35	400	2.0	—	—	1400	12.0	a	c
4169	CC	37	400	2.0	1200	17.0	1600	20.0	b	c
4178	CC	37	400	3.0	—	—	900	34.0	b	c
4212	CC	37	400	3.0	—	—	900	34.0	b	d
4223	CC	37	400	3.0	—	—	900	34.0	b	d
4241	CC	37	400	3.0	—	—	900	34.0	b	d
4242	CC	37	400	3.0	—	—	900	34.0	b	d
4245	CC	39	400	2.0	—	—	1400	12.0	a	c
1111212	CC	37	430	2.0	—	—	1400	27.0	e*	—
1111214	C	37	430	2.0	—	—	1400	27.0	e*	—

* Bronze bearing.

a Lower housing, bearing, and drive shaft housing I.D.—1.3782–1.3787; bearing I.D.—0.5903–0.5906, O.D. 1.3775–1.3780; drive shaft O.D.—0.5896–0.5902

b Lower housing, bearing, and drive shaft housing I.D.—1.3782–1.3787; bearing I.D.—0.5903–0.5906, O.D. 1.3775–1.3780; drive shaft O.D.—0.5905–0.5908

c Upper housing, bearing, and cam shaft housing I.D.—1.1809–1.1814; bearing I.D.—0.3934–0.3936, O.D. 1.1807–1.1811; cam shaft O.D.—0.3936–0.3939

d Upper housing, bearing, and cam shaft housing—1.1808–1.1814; bearing I.D.—0.3934–0.3937, O.D. 1.1807–1.1811; cam shaft O.D.—0.3936–0.3939

e Housing I.D.—0.5000–0.5005; shaft O.D.—0.4993–0.4997

C Clockwise rotation viewing drive end.

CC Counterclockwise rotation viewing drive end.

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 4

DISTRIBUTORS (Cont'd)

Section IV

GROUP III—SPECIAL MOUNTINGS

	Paragraph
Description	104
Cleaning, inspection, and test	105
Disassembly	106
Cleaning, inspection, and test of parts	107
Assembly	108
Tests and adjustments	109
Test data and tolerances	110

104. DESCRIPTION.

a. The distributors in this group may have single or dual contact points, but all have some type of special mounting and drive arrangement. The distributors fall into two classifications, those which are of standard construction but mounted into a special mounting base (fig. 121), and those of special construction assembled into a special housing so that a special disassembly and assembly procedure is required (fig. 123).

105. CLEANING, INSPECTION, AND TEST.

- a. **Cleaning.** Refer to paragraph 91 a.
- b. **Inspection.** Refer to paragraph 91 b.
- c. **Test.** Refer to paragraphs 91 c and 102.

106. DISASSEMBLY.

a. The disassembly procedure on the standard type distributor which is mounted in a special mounting base is identical with group I or group II distributors (according to type) with the addition (fig. 122) of removing the drive shaft from the mounting base, along with the bearings, by taking out the drive end plate attaching screws. The shaft, gear, and bearings are also removed from the shaft. For the type distributor assembled into a special housing with a special mounting and drive arrangement, a special disassembly procedure is outlined below (fig. 124).

b. **Detach Distributor Cap.** Unsnap two distributor cap springs, and detach distributor cap.

c. **Lift Off Rotor.** Lift rotor off breaker cam. If rotor is a tight fit, it may be necessary to pry gently under rotor just above breaker cam, with screwdriver fulcrumed on edge of distributor housing. Be very careful to avoid damaging rotor or housing. Do not pry on rotor tips.

GROUP III—SPECIAL MOUNTINGS

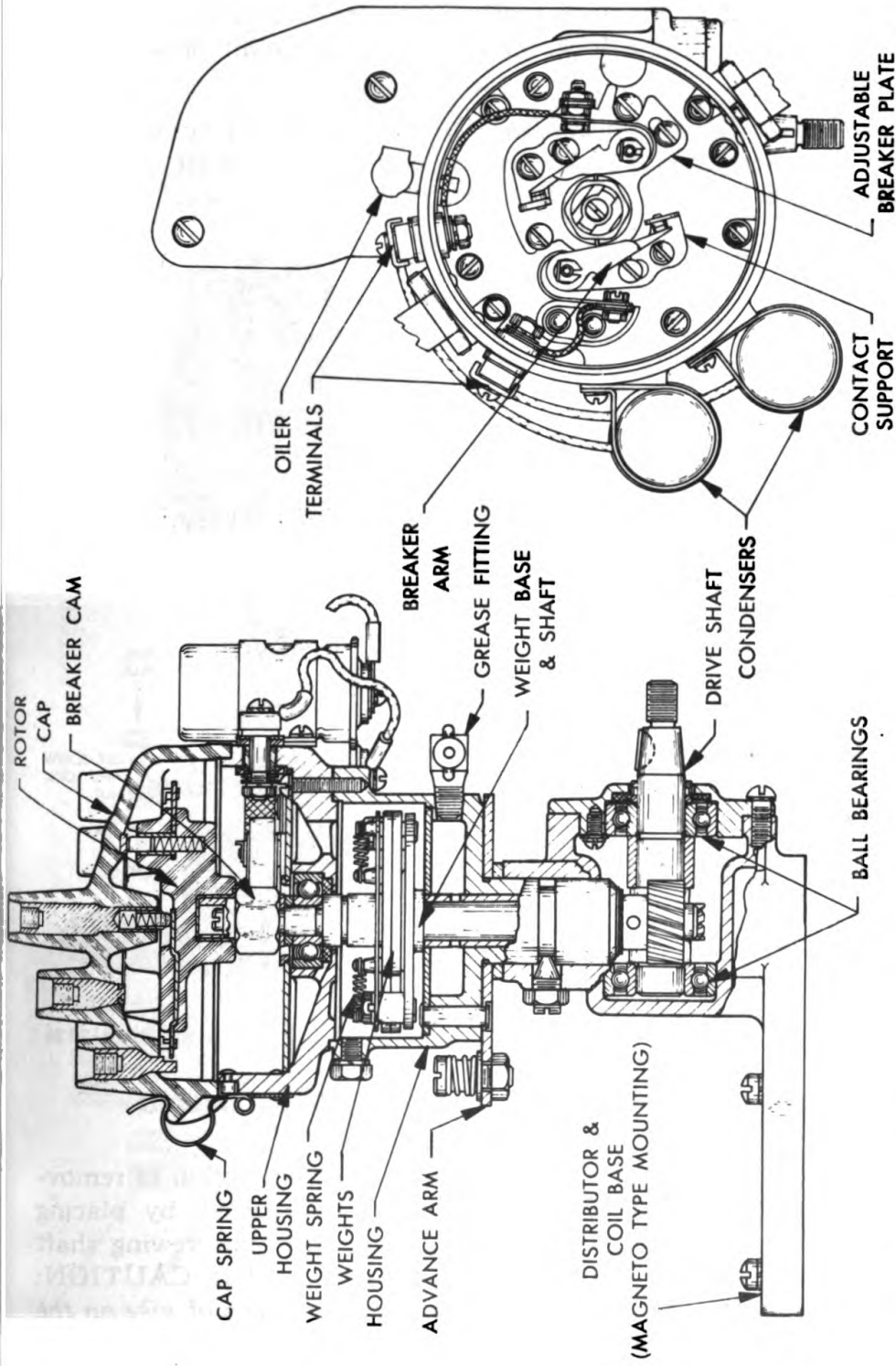
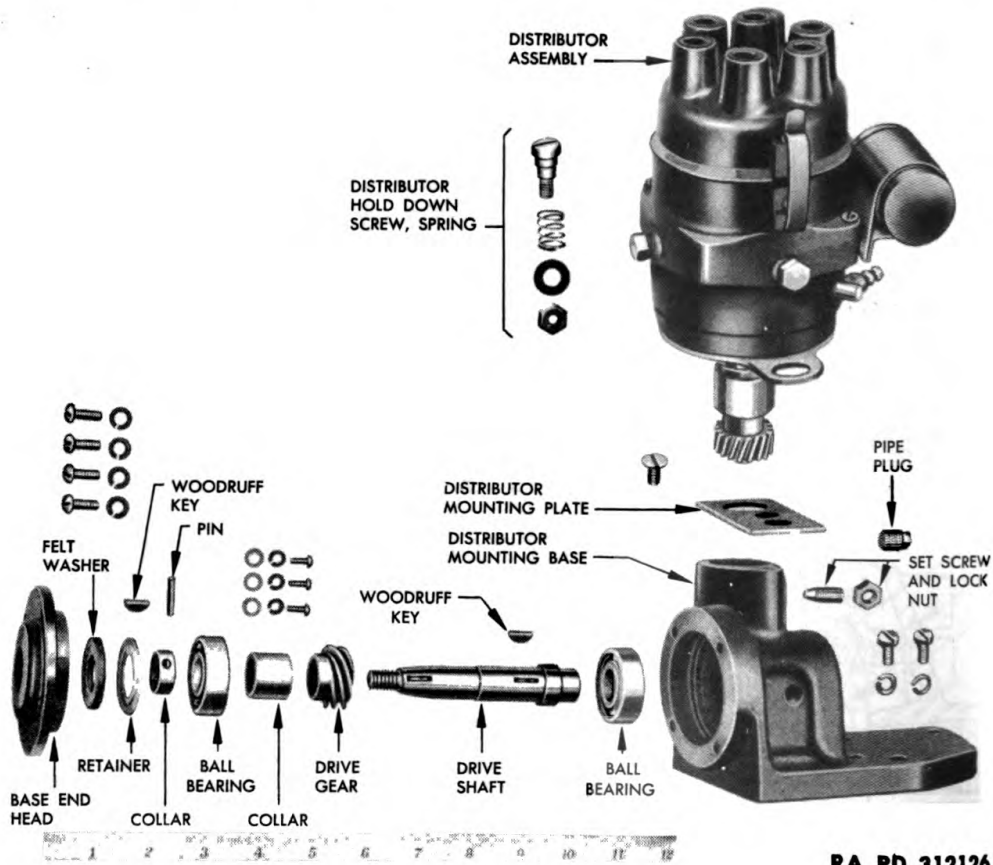


Figure 121—Sectional View of Standard Type Distributor with Special Mounting Base
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**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

d. **Detach Circuit Breaker Plate Assembly.** Remove terminal nut, flat washer, insulating washer, insulating bushing, insulating washer, flat washer, and lock washer from each terminal assembly. Remove four screws and lock washers, and lift circuit breaker plate assembly out.

e. **Remove Drive Shaft and Bearing.** Cut safety wire, and remove four screws and lock washers holding drive shaft oil seal to the distributor housing. Pull drive shaft with gear, oil seal, and bear-

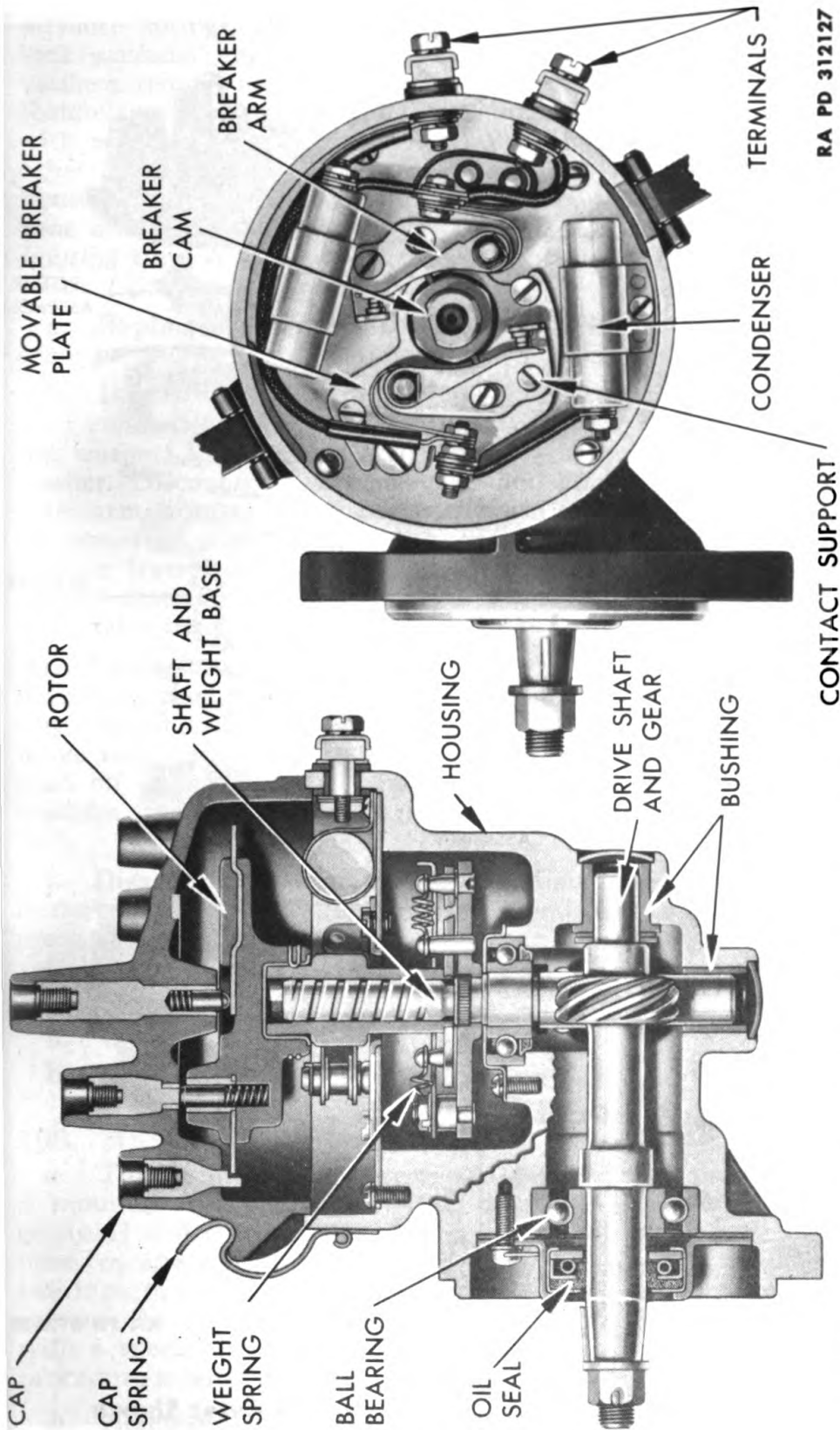


RA PD 312126

Figure 122—Special Mounting Base, Disassembled

ing from housing. Turn shaft in counterclockwise direction in removing, to demesh gears. Disassemble further, if required, by placing drive shaft in soft jaws of vise, pulling cotter pin, unscrewing shaft nut and removing gear, oil seal, and bearing from shaft. **CAUTION:** *The drive shaft must be carefully gripped in soft jaws of vise on the section just back of the integral gear. The section to be gripped by the vise is about 1/4 inch long and about 5/8 inch in diameter. Do not grip bearing on end of shaft, nor the integral gear. Use an arbor press if necessary, to press off the ball bearing.*

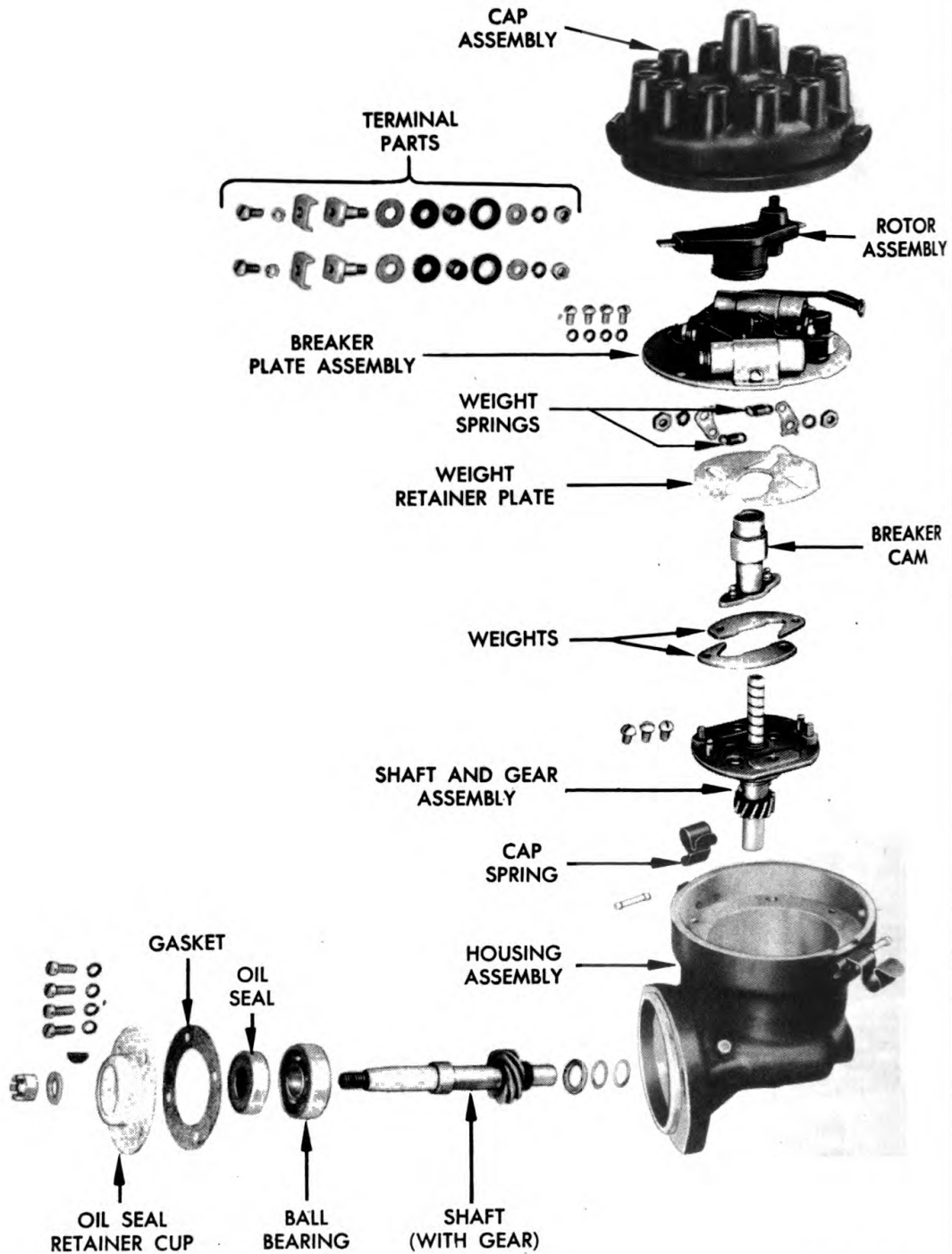
GROUP III—SPECIAL MOUNTINGS



RA PD 312127

Figure 123—Sectional View of Distributor with Special Housing, Mounting, and Drive Arrangement

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**



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**Figure 124—Disassembled View of Distributor Shown
in Figure 123**

GROUP III—SPECIAL MOUNTINGS

f. **Remove Main Shaft and Advance Mechanism.** Remove two advance springs. Bend down two tangs on hold-down cover nut, lock washers, and unscrew two nuts. Remove and discard lock washers, remove hold-down cover, advance weights and breaker cam. Rotate shaft and weight plate until large hole in weight plate aligns with screw. Remove screw and lock washer. Repeat procedure for other two screws which are holding ball bearing retainer plate to housing and remove shaft and weight plate with ball bearing, collar, gear and pin, as an assembly. *NOTE: Insert a screwdriver into housing through drive shaft opening and pry gently upward on the vertical shaft gear, if necessary.*

g. **Replace Housing Bushings.** Press bushings out of housing in arbor press if necessary and install new bushings.

h. **Disassemble Circuit Breaker Plate** (fig. 119). Remove from each condenser terminal, one nut, flat washer, connector, and thick flat washer. Remove two condensers by unscrewing screw and lock washer. Disconnect two connectors and stationary contact breaker lever arm from insulated bracket, which is riveted to breaker plate, by removing screw, flat washer, and nut. Remove clip and lift off breaker lever from stationary set of points. Remove lock screw and lift off stationary point. Remove two lock screws and lift off the adjustable breaker plate assembly.

i. **Disassemble Adjustable Breaker Plate Assembly** (fig. 120). Remove nut and lock washer holding breaker lever spring to stud. Slip clip off and remove breaker lever and long lead from stud. Remove nut, washer, connector, and insulating washer from stud. Slip stud off and remove two small insulating and one large insulating washers from stud. Unscrew lock screw and detach stationary contact.

j. **Disassemble Main Shaft and Gear Assembly** (fig. 125). Remove pin from shaft, and press gear and bearing off shaft in arbor press.

107. CLEANING, INSPECTION, AND TEST OF PARTS.

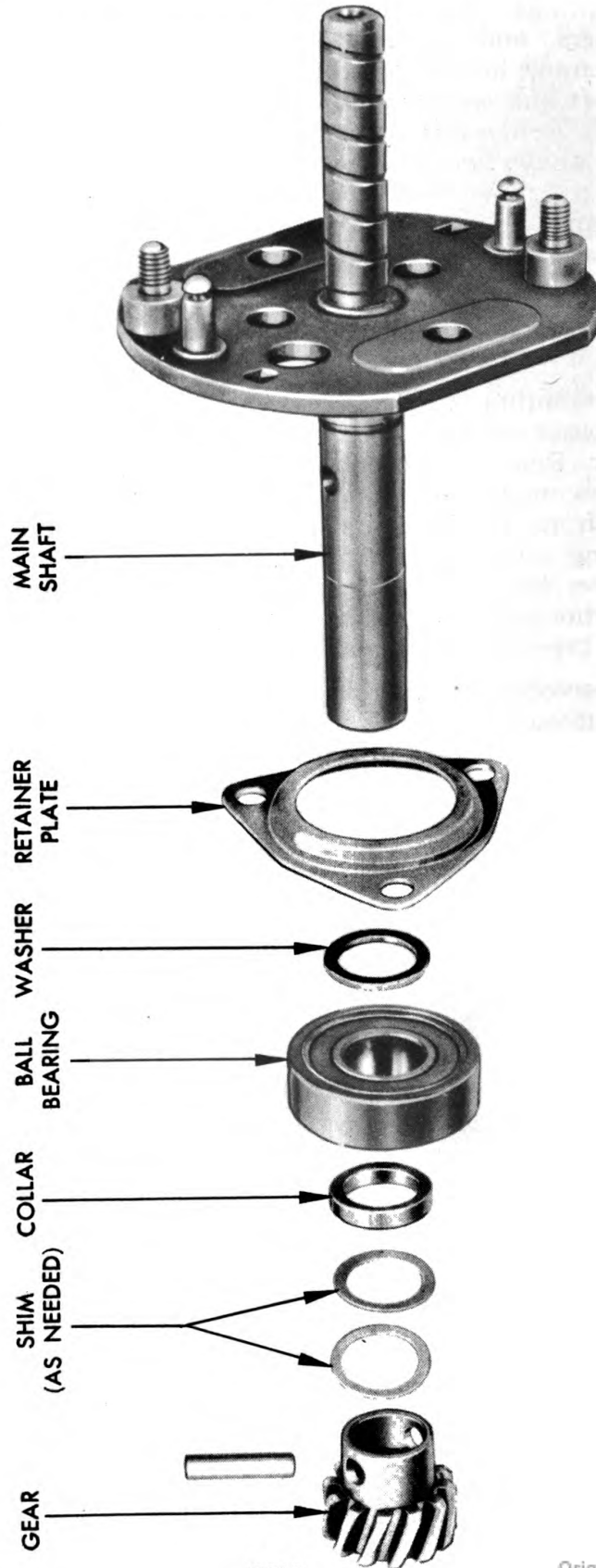
- a. **General.** Refer to paragraph 93 a.
- b. **Ball Bearings.** Refer to paragraph 100 b.

108. ASSEMBLY.

a. The assembly procedure on the standard type distributor which is mounted in a special mounting base is identical with group I or group II distributors (according to type) except that the mounting base requires some additional assembly. Attach shaft, with gear and bearings, to mounting base and secure with drive end plate attaching screws. On the type distributor assembled into a special housing with a special mounting and drive arrangement, a special assembly procedure is outlined below (fig. 124).

b. **Assemble Main Shaft and Gear** (fig. 125). Put bearing retainer on bearing, and press bearing onto shaft, with the shielded side down

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RA PD 40325

Figure 125—Disassembled View of Drive Shaft Used in Distributor Shown in Figure 123

GROUP III—SPECIAL MOUNTINGS

or away from weight plate. Add spacing collar, shims, and gear. Shims must be just sufficient to prevent any end play of collar. Secure gear with pin, peening or pressing both ends of pin over so that there will not be any interference with mating gear.

c. **Assemble Adjustable Breaker Plate Assembly** (fig. 120). On long end of stud, place one large and two small insulating washers and place stud into bracket hole. Secure with large insulating washer, connector, lock washer and nut. Put stationary contact support in position, and secure with lock screw. On short end of stud, place clip of long lead. Compress spring of breaker lever between thumb and forefinger, slip breaker lever down over post, with slot in spring on short end of stud. Secure with washer and nut. Put clip on post.

d. **Assemble Circuit Breaker Plate** (fig. 119). Attach adjustable breaker plate with two lock screws. Attach stationary point support with lock screw. Install breaker lever on post with spring on inside of insulated bracket, and secure with clip. Place flat washer on screw and slip screw through slot in breaker lever spring and hole in insulated bracket. Attach two connectors to opposite side, and secure with nut. Attach two condensers in position with lock washers and screws. Place thick washers on condenser terminals, followed by connectors, flat washers, lock washers, and nuts.

e. **Install Main Shaft and Advance Mechanism** (fig. 124). Install main shaft. Working through large hole in advance plate, secure bearing retainer plate with three screws and lock washers. Put advance weights, breaker cam, hold-down cover, and lock washers, in place and secure with two nuts. Use screwdriver to bend up two tangs of lock washers against two faces of nuts. Install advance springs with pliers, being careful to avoid crushing springs.

f. **Install Drive Shaft and Bearing** (fig. 124). Install bearing and oil seal on drive shaft, followed by cotter key, gear, nut, and cotter pin to secure nut. Press bearing in arbor press, and hold shaft in soft jaws of vise while nut is tightened. Grip section of shaft just back of gear, but not on end bearing. Install assembly in housing, rotating shaft in clockwise direction as it is inserted so gears will mesh. Attach oil seal with four screws and lock washers, thread 0.032 safety wire through holes in screw heads and twist together.

g. **Attach Circuit Breaker Plate Assembly**. Attach circuit breaker plate with four screws and lock washers. Circuit breaker can be installed in one way only. Install terminals by placing on them, flat washer, insulating washer, and bushing. Then install in housing and add insulating washer, flat washer, connector, lead clip, lock washer, and nut.

h. Install rotor and cap.

109. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 102.

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

110. TEST DATA AND TOLERANCES.

a. Data.

Model	Rotation	Cam Angle Deg	Start Advance		Intermediate Advance		Maximum Advance	
			RPM Eng	Deg Eng	RPM Eng	Deg Eng	RPM Eng	Deg Eng
1111404	CC	37	400	2.0	800	14.0	1800	24.0
1111405	CC	35	600	1.0	—	—	2000	20.0
1111527	CC	37	500	2.0	2500	18.0	3000	22.0
1111528	CC	37	500	2.0	2500	18.0	3000	22.0

b. Fits and Tolerances.

(1) DISTRIBUTOR MODEL 1111404.

(a) *Base, Horizontal Drive Shaft and Bearings.* I.D. of Base—1.3784 to 1.3790 inches. Ball bearing on both ends of horizontal drive shaft I.D.—0.5903 to 0.5906 inch. O.D.—1.3775 to 1.3780 inches. End plate I.D.—1.3782 to 1.3787 inches. Horizontal drive shaft O.D., drive end—0.5896 to 0.5902 inch, gear end—0.5903 to 0.5909 inch.

(b) *Upper Housing, Bearing, and Cam Shaft.* Upper housing I.D.—1.1809 to 1.1814 inches. Upper bearing O.D.—1.1807 to 1.1811 inches, I.D.—0.3934 to 0.3937 inch, cam shaft O.D.—0.3936 to 0.3939 inch.

(2) DISTRIBUTOR MODEL 1111405.

(a) *Base, Horizontal Drive Shaft, and Ball Bearings.* I.D. of Base—1.3784 to 1.3790 inches. Ball bearing, drive end and gear end of horizontal drive shaft I.D.—0.5903 to 0.5906 inch, O.D.—1.3775 to 1.3780 inches. End plate I.D.—1.3782 to 1.3787 inches. Horizontal drive shaft O.D. drive end—0.5896 to 0.5902 inch, gear end—0.5903 to 0.5909 inch.

(3) DISTRIBUTOR MODELS 1111527 AND 1111528.

(a) *Base, Bearings, and Horizontal Shaft.* Base I.D.—1.6534 to 1.6540 inches and 0.4905 to 0.4910* inch. Ball bearing I.D.—0.5903 to 0.5906 inch, O.D.—1.6530 to 1.6535 inches. Horizontal shaft O.D.—Drive end—0.5890 to 0.5900 inch, gear end—0.4895 to 0.4900 inch.

(b) *Upper Housing, Bearing, and Vertical Shaft.* Upper housing O.D.—1.2599 to 1.2604 inches. Ball bearing I.D.—0.5115 to 0.5118 inch, O.D.—1.2593 to 1.2598 inches, shaft O.D.—0.5117 to 0.5120 inch.

* Bronze bearing.

CC Counterclockwise rotation viewing drive end.

CHAPTER 5 CRANKING MOTORS

Section I

BASIC PRINCIPLES OF OPERATION

	Paragraph
Construction and function	111
Operation	112

111. CONSTRUCTION AND FUNCTION.

a. Cranking motors are designed to electrically crank engines. They are made up of an armature, a field frame with field coils, end frames or heads to support the armature, and a drive arrangement to transmit the cranking effort from the armature to the engine flywheel.

112. OPERATION.

a. The armature and field coils draw current from the battery when the cranking motor switch is closed. This produces magnetic fields that so oppose each other as to cause the armature to spin or rotate in the cranking motor. This rotary motion is carried through the cranking motor drive pinion to the engine flywheel so that the engine is cranked. Three types of drive arrangements are used, Bendix, overrunning clutch, and Dyer. There are several variations of the Bendix type drive. These are covered in following sections which discuss the various groups of cranking motors.

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 5
CRANKING MOTORS (Cont'd)

Section II

GROUP I—CRANKING MOTORS LESS DRIVE
MECHANISM

	Paragraph
Description	113
Cleaning, inspection and test	114
Disassembly	115
Cleaning, inspection, and test of parts	116
Repair of parts	117
Assembly of cranking motor	118
Tests	119
Test data and tolerances	120

113. DESCRIPTION.

a. Some cranking motors in this group do not have the drive mechanism assembled on the cranking motor; it is separately mounted on the engine (fig. 126). Others use either a Bendix inboard or outboard type drive. Figure 131 illustrates an inboard drive. The drive pinion moves in toward the cranking motor in meshing. The outboard type drive is similar in construction except that the drive arrangement is reversed so the drive pinion moves out from the cranking motor in meshing. All use the swivel type brush holder. Some have a magnetic switch mounted on the field frame, others have a manual switch or a terminal on the field frame. Figures 126 through 132 illustrate these variations.

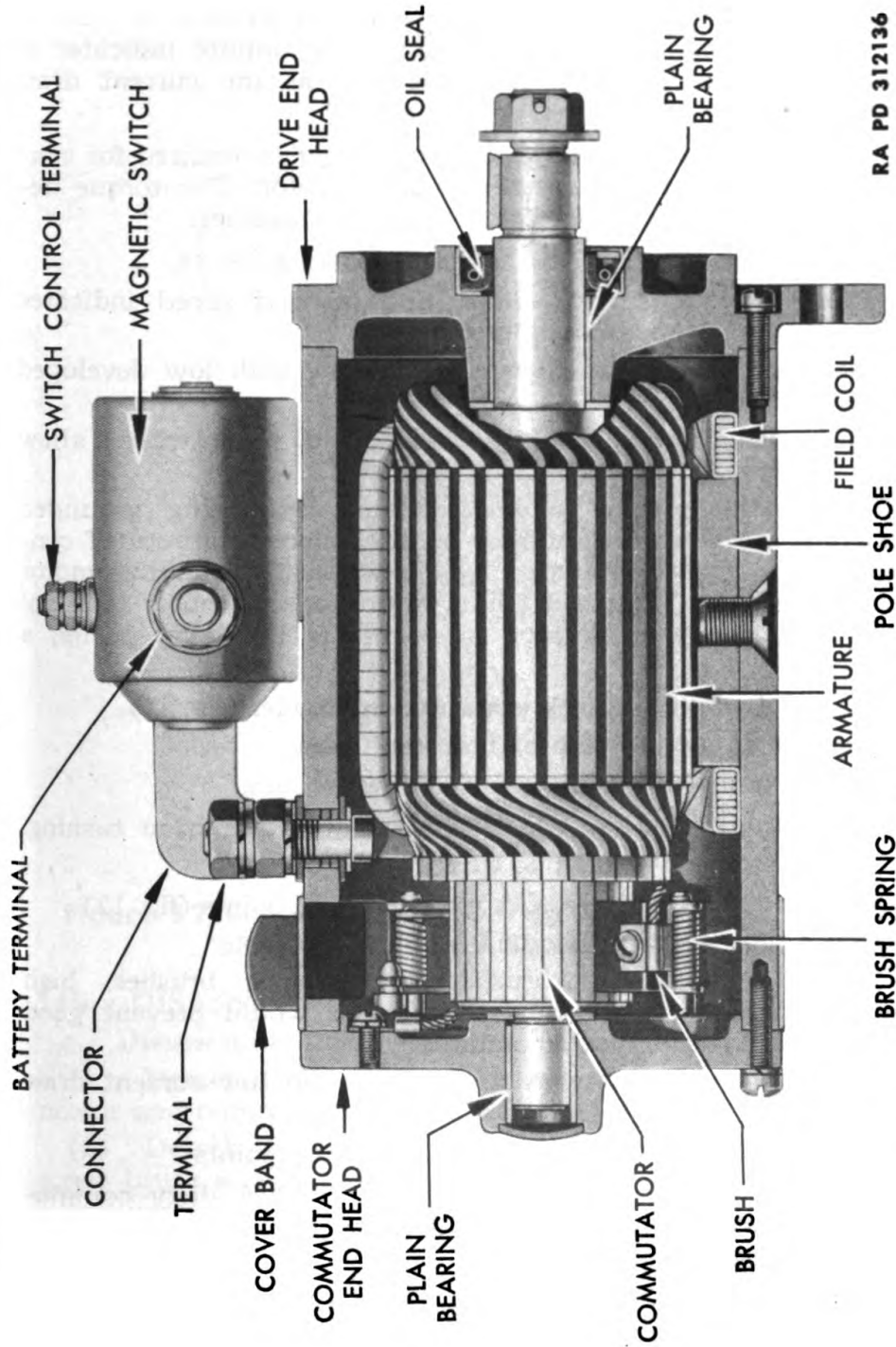
114. CLEANING, INSPECTION, AND TEST.

a. **Cleaning.** Wipe off grease and dirt with a clean cloth. Do not steam-clean or dip-clean cranking motor, and avoid getting any water or cleaner into the cranking motor. Handle unit carefully to avoid battering or bending terminal studs, cover band, or magnetic switch (where present).

b. **Inspection.** Inspect the cranking motor for damage. Remove cover band and inspect for sticking or worn brushes, rough, out-of-round, dirty or burned commutator, or high mica on commutator. Inspect all visible connections, screws, insulators, terminal studs, leads, and washers. Any apparent defect requires disassembly and correction, as outlined below.

c. **Test** (par. 120). Place cranking motor on test stand. If it does not operate according to specifications, some idea as to the cause of trouble can be obtained according to the malfunction observed.

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM



RA PD 312136

Figure 126—Sectional View of Cranking Motor without Drive, with Magnetic Switch and Swivel Brush Holders

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

Added information can be gained by using a set of test points (fig. 12). The tests, and their interpretation, are given below.

(1) **NO-LOAD TEST.** Connect the cranking motor in series with a battery of the specified voltage and an ammeter capable of reading several hundred amperes. If a revolutions per minute indicator is available, read the armature speed as well as the current draw with the unit running free speed or no load.

(2) **TORQUE TEST.** Torque testing equipment is required for conducting a stall torque test of the cranking motor. The torque developed, current draw, and voltage are checked together.

(3) **INTERPRETATION OF NO-LOAD AND TORQUE TESTS.**

(a) Rated torque, current draw, and no-load speed indicates normal condition of the cranking motor.

(b) Low free speed and high current draw with low developed torque may result from:

1. Tight, dirty, worn bearings, loose field poles which allow armature to drag.

2. *Grounded Armature or Field.* Check by raising grounded brushes from armature commutator or disconnecting grounded connections where field is grounded by screws inside cranking motor and testing with test lamp and points from cranking motor terminal to frame and from commutator to frame. If the lamp lights, a ground exists.

3. *Shorted Armature.* Check armature on growler (fig. 21).

(c) Failure to operate with high current draw:

1. Direct ground in switch, at terminal or brushes.

2. Frozen shaft bearings which prevent armature from turning.

(d) Failure to operate with no current draw:

1. Open field circuit. Trace with test lamp and points (fig. 12).

2. Open armature coils (par. 116 b (2)).

3. Broken or weakened brush springs, worn brushes, high commutator mica, or other conditions which would prevent good contact between brushes and commutator.

(e) Low no-load speed with low torque and low current draw indicates:

1. *Open Field.* Trace circuit with test lamp and points.

2. High internal resistance due to worn brushes, dirty commutator, weak or worn brush springs, and other causes of poor contact between commutator and brushes.

3. *Defective Leads, Connections.*

(f) High free speed with low developed torque and high current draw indicates shorted fields. It is difficult to detect shorted fields with ordinary testing instruments, since the field resistance is originally low. If shorted fields are suspected, install new fields and check for improvement in performance.

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM

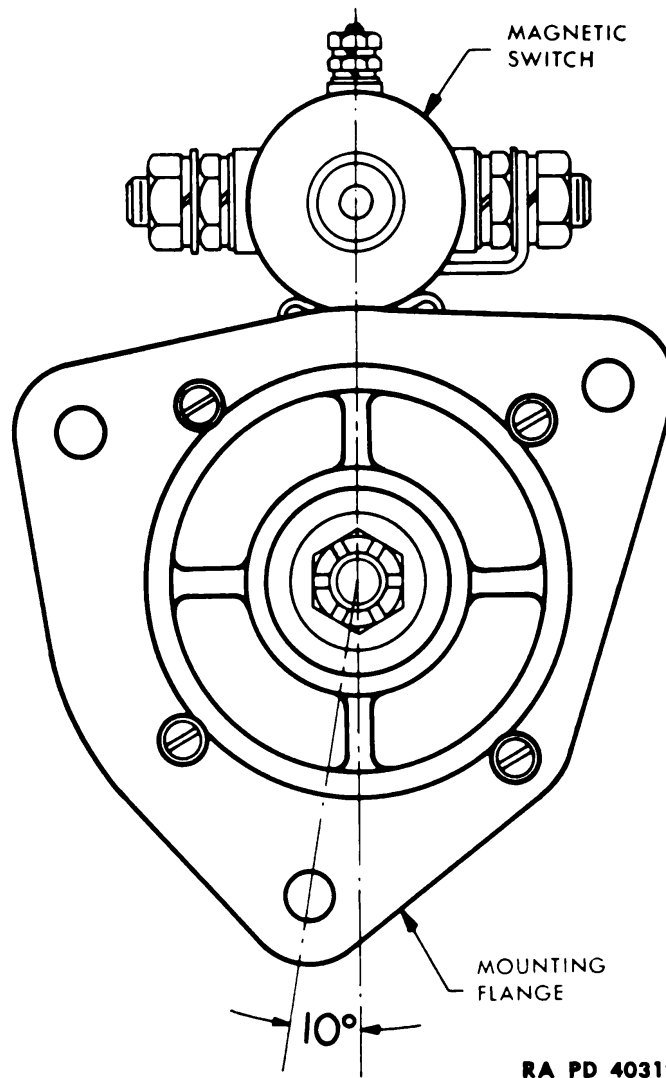


Figure 127—Relation of Mounting Flange to Magnetic Switch of Cranking Motor Shown in Figure 126

115. DISASSEMBLY.

a. Disassembly Into Main Subassemblies (figs. 128 and 131).

(1) Detach magnetic switch, where present, by disconnecting connector and removing attaching screws.

(2) Detach commutator end head by removing cover band, unscrew brush screws and detach field coil lead clips and then remove commutator end head attaching screws and lock washers. If necessary, tap the commutator end head lightly with a soft hammer to loosen it.

(3) Remove field frame by taking out four screws and lock washers. Tap drive end head away from field frame with soft hammer.

(4) Disassemble Bendix drive (fig. 132) by pulling cotter pin and removing from shaft in order named, shaft, nut, spacing collar,

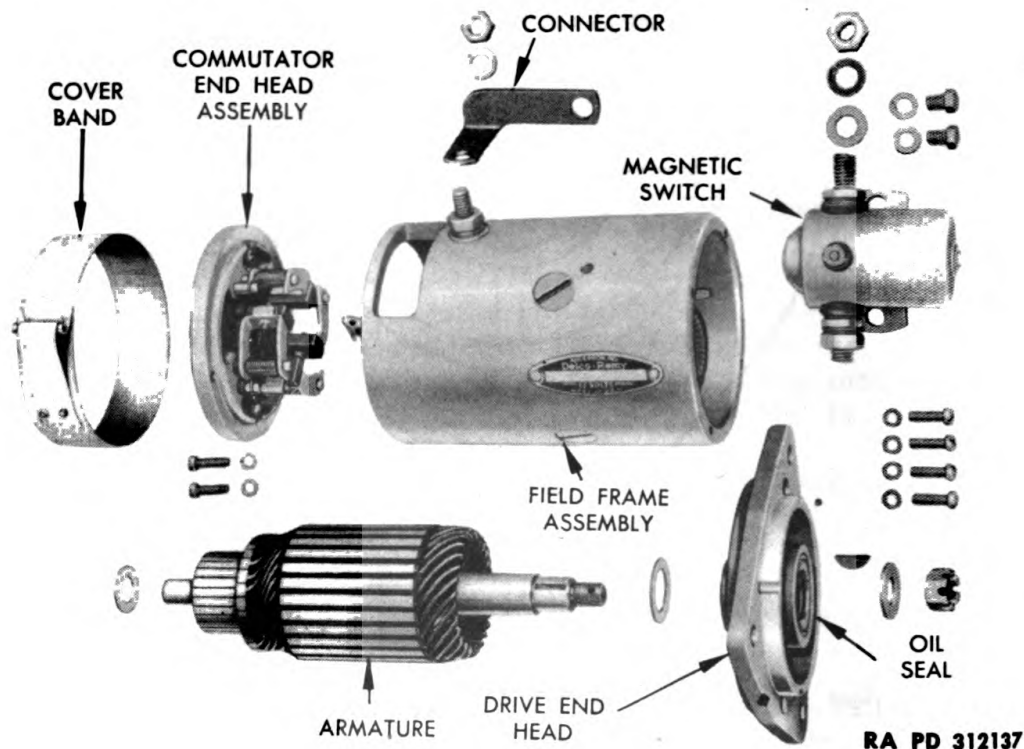
**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

drive spring, spring support, meshing spring, thrust washer, screw sleeve, drive pinion, antidrift spring sleeve, antidrift spring, and cup. Drive end head will now slip off armature shaft. **NOTE:** On outboard Bendix, reverse order of disassembling Bendix drive parts.

b. Disassemble Commutator End Head (fig. 129).

(1) Remove four brush attaching screws, lock washers, and brushes.

(2) Catch short hooked end of brush arm spring and slip off brush holder stop pin. Slip brush holder and brush spring off brush holder hinge pin.



**Figure 128—Disassembled View of Cranking Motor Shown
in Figure 126**

(3) Detach the two brush grounding leads by removing two screws and lock washers. Press brush holder stop pins and brush holder hinge pins out if they are defective. Press bushing out if it requires replacement.

c. Disassemble Field Frame (fig. 130).

(1) Unsolder field coils from terminal stud.

(2) Remove four pole shoe screws with pole shoe screwdriver (fig. 17), and remove four pole shoes and coils from field frame. Be careful with coils to avoid bending lead connections or damaging insulation.

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM

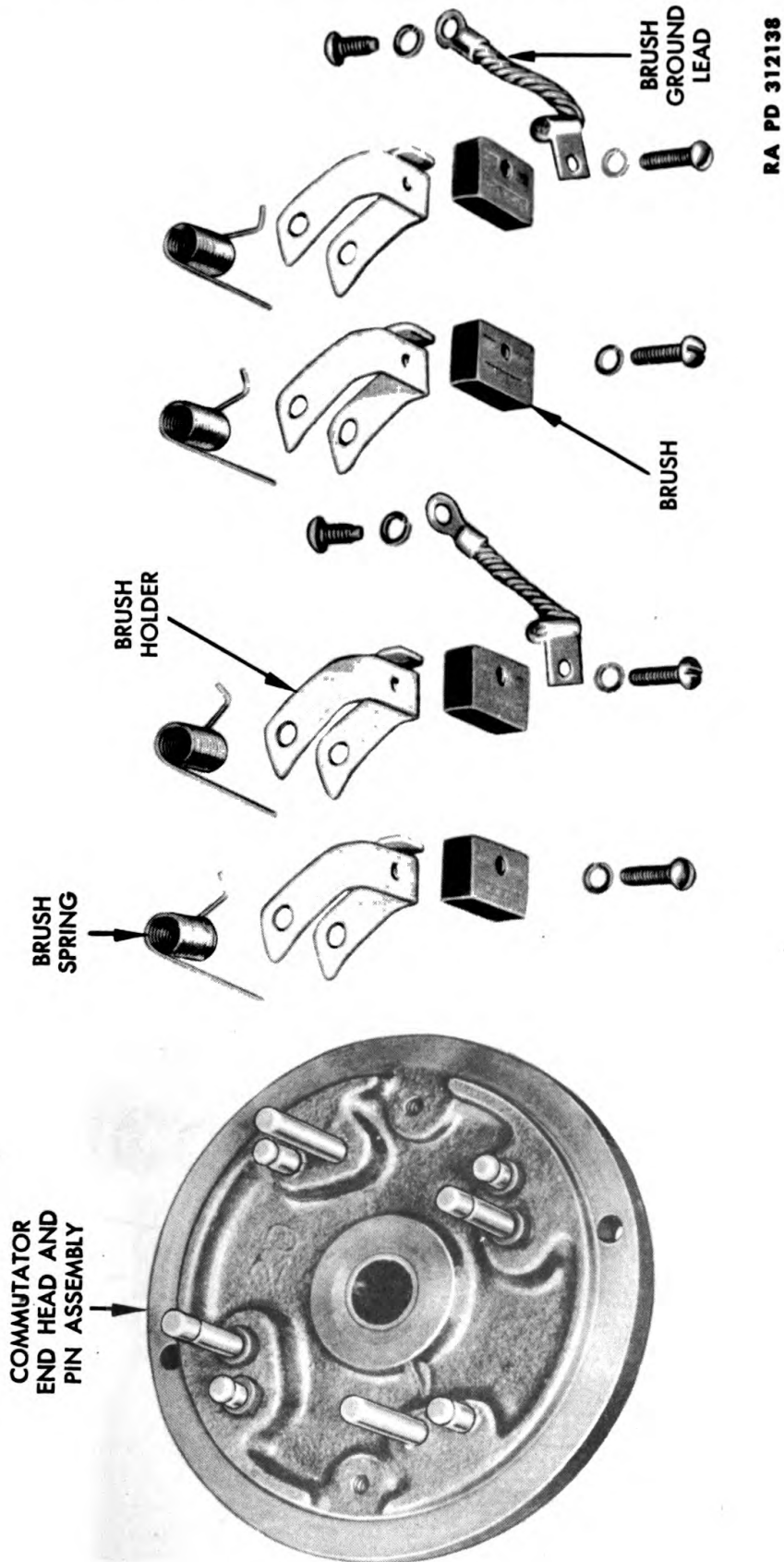
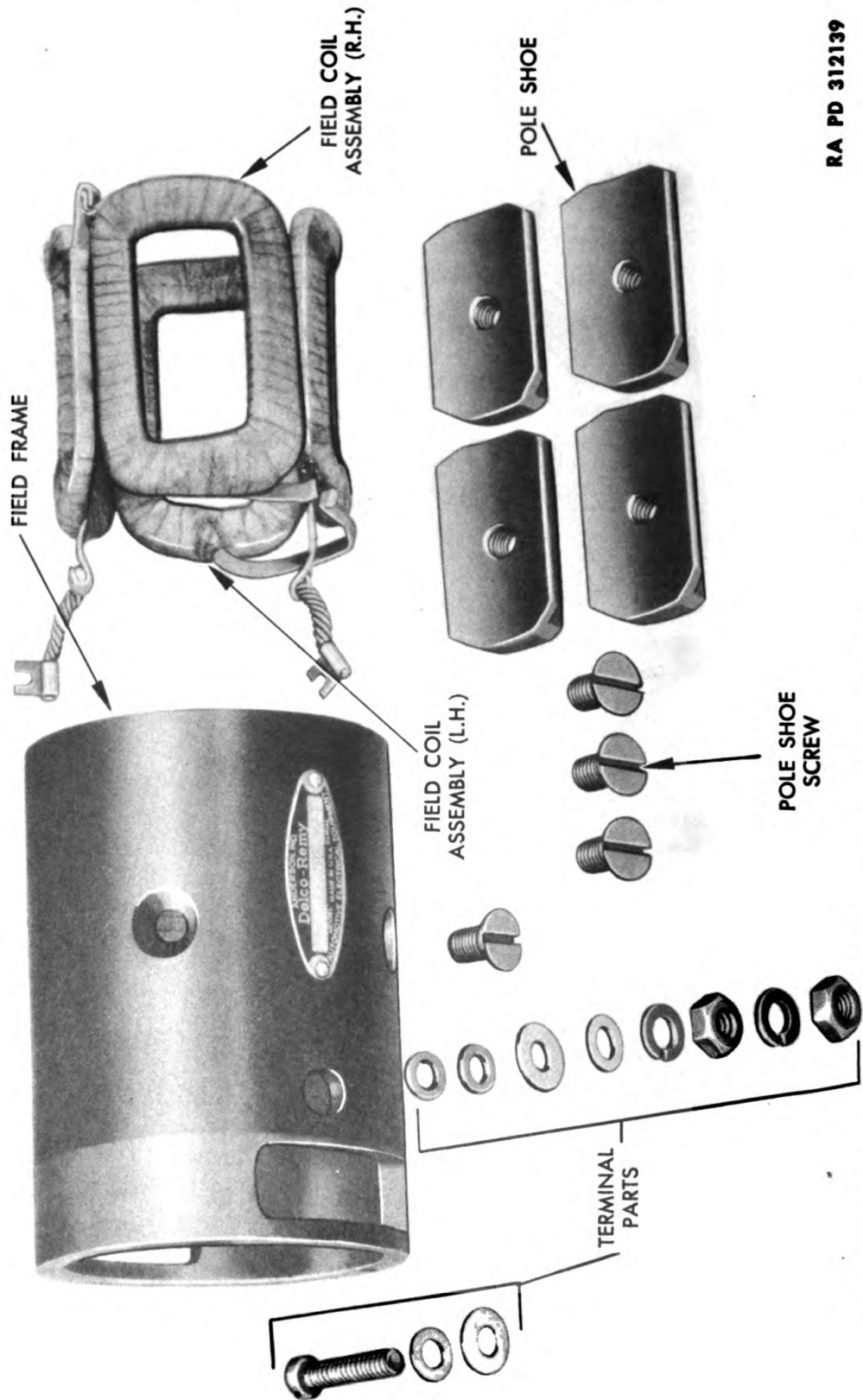


Figure 129—Disassembled View of Commutator End Head of Cranking Motor Shown in Figure 126

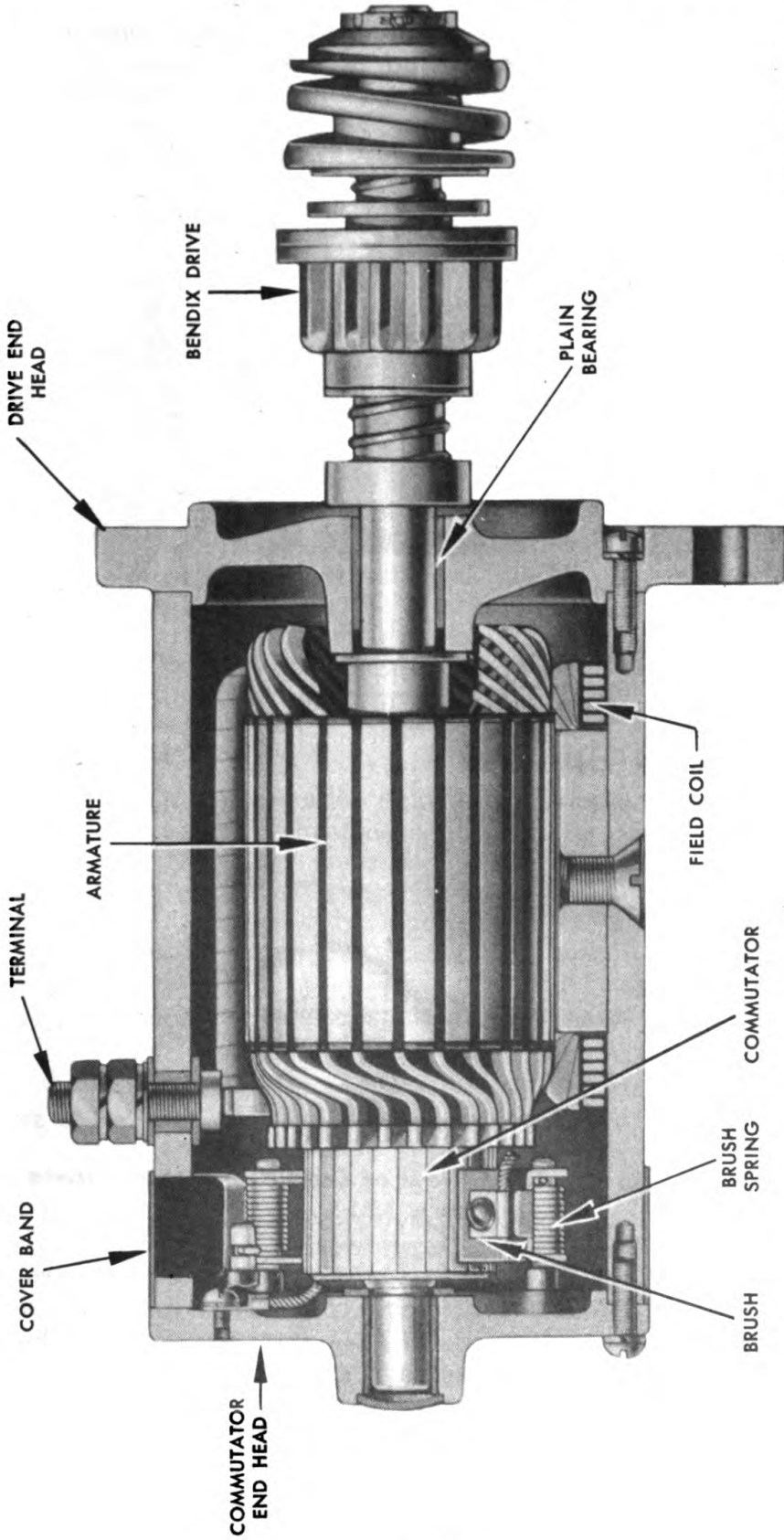
ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312139

Figure 130—Disassembled View of Field Frame of Cranking Motor Shown in Figure 126

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM



RA PD 312140

Figure 131—Sectional View of Cranking Motor with Swivel Brush Holders and Inboard Bendix Drive

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**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

(3) Remove nut, lock washer, nut, lock washer, washer, and insulating washer from terminal stud. Remove terminal stud from field frame and slip two bushings, insulating washer, and washer off stud. *NOTE: Stack up of parts may vary between models. Notice relationship of parts during disassembly so they can be reassembled correctly. Some field coils are varnished and baked in place in the field frame and cannot be removed. If field coils are baked in place,*

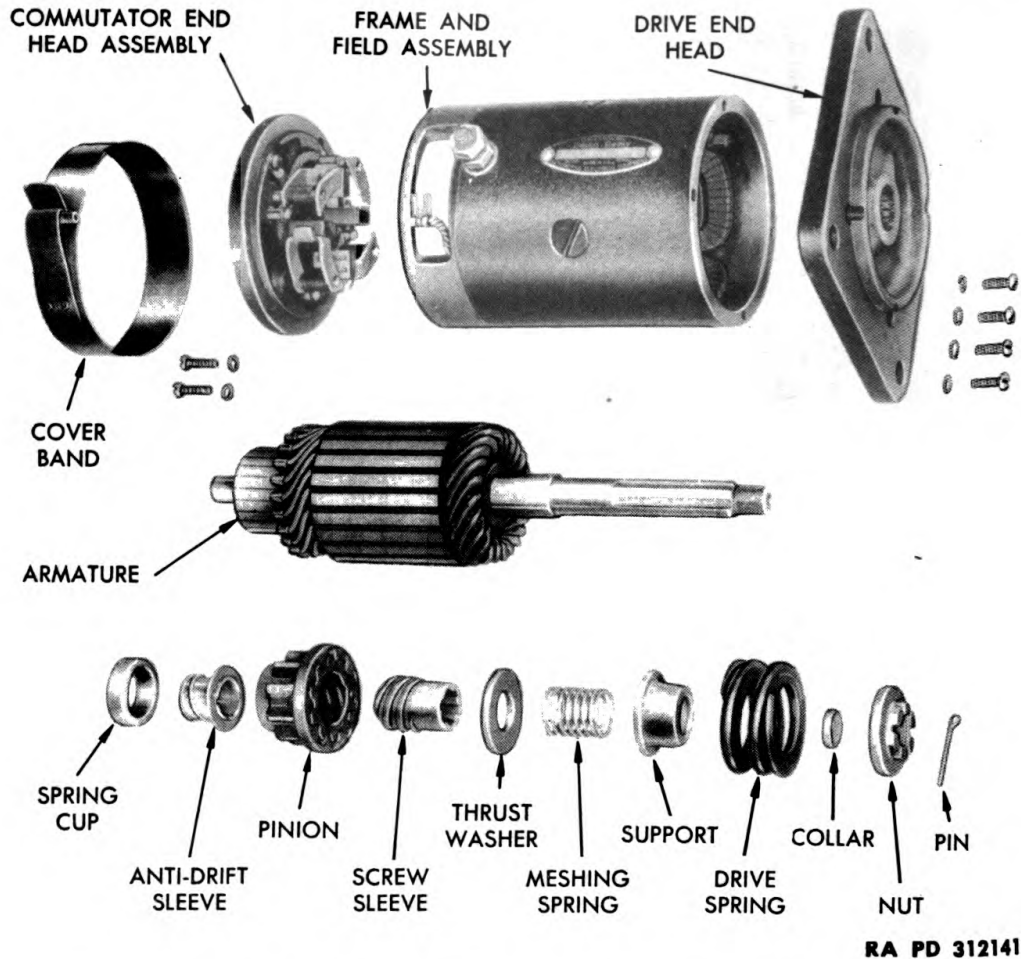


Figure 132—Disassembled View of Cranking Motor Shown in Figure 131

they are not serviceable separately and defective field coils require replacement of field and frame assembly complete.

d. **Disassemble Drive End Head Assembly.** Press out old bushing if it is worn so a new bushing can be pressed into place.

116. CLEANING, INSPECTION, AND TEST OF PARTS.

a. **General.** After disassembly, clean and examine all parts and replace defective parts. The procedure of cleaning and inspecting parts is given in the following paragraphs.

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM

b. Armature. Do not clean the armature by any degreasing method, since this would damage the insulation and ruin the armature. Wipe with a clean cloth slightly dampened with dry-cleaning solvent. If commutator is rough, out of round, has high mica, filled slots, or is burned, turn it down in a lathe and undercut the mica. Check armature for ground, open, or short circuit as follows:

(1) **GROUND.** Check with test lamp and test points from the commutator to the armature shaft or lamination. If the lamp lights, indicating ground, and if the ground is not readily apparent and repairable, replace the armature.

(2) **OPEN.** An open circuited armature is often easy to detect, since this condition produces badly burned commutator bars. The bars connected to the open armature windings soon burn in operation since every time they pass under the brushes they interrupt a flow of current so that heavy arcing occurs. If the bars are not badly burned, the armature may be saved (par. 117 a (2)).

(3) **SHORT.** A shorted armature may be detected on a growler. The growler is a strong electromagnet connected to a source of alternating current. When a shorted armature is placed on the growler and a hacksaw blade held above the shorted coils in the armature, the blade will be alternately attracted to, and repelled from the armature, causing the blade to vibrate against the armature. Before discarding an armature testing shorted, inspect the commutator slots carefully, since copper or brush dust sometimes collects in the slots and shorts adjacent bars.

c. Fields. Do not clean the fields by any degreasing method, since this would damage the insulation and ruin the windings. Clean by wiping with a clean, dry cloth. Be careful in handling the windings to avoid breaking or weakening the connecting straps between windings. If the field insulation is charred or chafed so that the windings are exposed, it is sometimes possible to rewrap them. It must be remembered that if the wrapping is done carelessly so the insulation bulks up too large, it will be impossible to reassemble the coils under the pole shoes. Make all soldered connections using a rosin flux.

d. Brushes. If the brushes are worn down to $\frac{1}{2}$ their original length (par. 120), replace. Make sure that the pigtail leads (where part of brush assembly) are tight in the brushes, and that the clips are fastened well to the leads.

e. Brush Springs. The brush springs must have sufficient tension to provide the proper pressure between the brushes and commutator after the unit is assembled. Check by placing the armature and commutator end frame together in their normal operating position. Place the brushes in their holders with the springs in place so that the tension of the brushes against the commutator can be measured with a spring gage. Replace springs if the tension is not correct.

f. Bearings. Replace plain bearings, if worn. Wear will not be even, but on the side which sustains the greatest thrust during cranking. Ball bearings that roll roughly or sloppily are defective; replace. Otherwise, clean ball bearings, if not of sealed type, by rotating them

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in dry-cleaning solvent, drying them with air, and immediately relubricating them with ball bearing grease. Do not attempt to clean sealed ball bearings but replace them if defective. Where plain bearing is lubricated by a wick, drill oil lead in side for oil wick after installation of new bearing and before machining to size. Remove all cuttings and install new wick.

g. Brush Holders. If the brush holders, stop or hinge pins, are bent, warped, cracked, burned or otherwise damaged, replace.

h. Miscellaneous. Replace any defective insulator, screw, washer, lead, stud, plate, etc. Cracked, bent, worn, burned insulators, or washers are defective. Studs or screws which are bent, battered, broken, or which have crossed or damaged threads, are defective. Leads which have broken strands or frayed insulation are defective.

117. REPAIR OF PARTS.

a. Armature. Conditions in the armature requiring repair are:

(1) **COMMUTATOR WORN, DIRTY, OR ROUGH.** If the commutator is worn, dirty, rough, out-of-round, has high mica, filled slots, or burned spots, place the armature in a lathe and turn down the commutator (fig. 23). Make cut no deeper than necessary. If it is necessary to turn commutator down so much that the ends of the segments are less than $\frac{1}{16}$ inch thick, discard armature since the segments would be too thin to have sufficient strength. Undercut mica $\frac{1}{32}$ inch (fig. 24).

(2) **ARMATURE OPEN.** Some bars badly burned, with other bars fairly clean, indicates an open circuited armature. The open will usually be found at the commutator riser bars and is often a result of excessively long cranking periods which overheat the unit and cause the connections to become bad. Thrown solder is evidence of this condition. Repair by resoldering leads in riser bars (using a rosin flux) and turning down commutator. **NOTE:** *Some armatures are of a welded construction with leads welded to the riser bars, and they cannot be resoldered.*

b. Fields. Conditions in the field windings requiring repair are:

(1) **DEFECTIVE INSULATION.** If the insulation is charred, or worn away, so the field coils are, or could become, grounded, repair may sometimes be made by rewinding the coils. This operation must be executed with care and neatness, since excessive bulkiness of the tape will prevent reassembling the windings under the pole shoes in the proper manner. Make soldered connections using a rosin flux.

c. Plain Bearings. When new plain bearings are installed, machine them to size (par. 116 f).

118. ASSEMBLY OF CRANKING MOTOR.

a. Assemble Field Frame (fig. 130). Place field coils in position in frame with pole shoes, insert pole shoe spreader (fig. 25), tighten,

GROUP I—CRANKING MOTORS LESS DRIVE MECHANISM

and with pole shoe screwdriver (fig. 17), tighten pole shoe screws. Place washer, insulating washer, and two bushings on terminal stud, and insert stud through hole in field frame. Place on stud in order, insulating washer, flat washer, lock washer, nut, lock washers, nut. Solder coil leads to terminal stud.

b. Assemble Commutator End Head.

(1) **INSTALL BRUSH HOLDERS AND SPRINGS.** Slip brush arm springs and brush arms on hinge pins. Long tang of spring goes back of arm. Catch short hooked end of spring and hook over stop pin.

(2) **ATTACH BRUSHES.** Attach four brushes with screws and lock washers to brush holders. At same time, attach two brush grounding leads to brush holders of grounded brushes. Attach other end of leads to commutator end frame with screws and lock washers.

c. Assemble Bendix Drive, if Used. Install drive end head on armature. Install Bendix parts as follows: cup, antidrift spring and sleeve, drive pinion, screw sleeve, thrust washer, meshing spring support, drive spring, spring spacing collar, and shaft nut. Secure nut with cotter pin. Hold armature in soft jaws of vise during assembly.

d. Attach Field Frame. Place field frame in position so magnetic switch (where used) when mounted will have relationship to the drive end mounting flange as shown in figure 127. Secure with four screws and lock washers. Stake screws securely and fill holes level with Glyptol No. 1201, red, so screws will not back out in service.

e. Attach Commutator End. Put commutator end in place, lifting brushes up to clear commutator as commutator end is slipped into position. Secure with screws and lock washers. Fasten field coil lead clips to insulated brush holders. Snap cover band into place.

f. Attach magnetic switch, where used, with screws and lock washers. Connect connector to cranking motor terminal.

119. TESTS.

a. Follow testing procedure outlined in paragraph 114 c.

120. TEST DATA AND TOLERANCES.

a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		Torque ft-lb
			Amps	Volts	RPM	Amps	Volts	
824	C	36-40	90	23.3	6800	800	4.35	60
1109316	*	36-40	85	22.0	6000	500	3.0	25
1109454	C	24-28	60	5.7	6000	540	3.3	11.5
1109600	C	24-28	60	5.7	5000	400	3.34	8
1109655	CC	24-28	75	11.25	7000	590	6.1	18

* Clockwise and counterclockwise rotation.

C Clockwise rotation viewing drive end.

CC Counterclockwise rotation viewing drive end.

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b. Fits and Tolerances.

Nomenclature:

- C.E.—Commutator End
- Comm. Diam.—Commutator Diameter
- D.E.—Drive End
- I.D.—Inside Diameter
- O.D.—Outside Diameter

Model	Comm. Diam. (inch)	Armature Shaft C.E. (inch)	C.E. Ball Bearing I.D.	C.E. Ball Bearing (inch) O.D.	C.E. Head I.D. (inch)	Armature Shaft D.E. (inch)	D.E. Ball Bearing I.D.	D.E. Ball Bearing (inch) O.D.	D.E. Head I.D.
824	2.313	0.6835-0.6845	0.686-0.688*	—	—	0.9836-0.9841	0.9839-0.9843	2.0466-2.0472	2.0476
1109316	2.125	0.6684-0.6690	0.6690-0.6693	1.5743-1.5748	1.575-1.576	0.9836-0.9841	0.9839-0.9843	2.4404-2.4409	2.0481 2.4411
1109655	1.500	0.543-0.553	0.5615-0.5625*	—	—	0.746-0.747	0.7485-0.7505*	—	2.4419
1109454	1.500	0.4965-0.4975	0.5615-0.5625*	—	—	0.746-0.747	0.7485-0.7505*	—	—
1109600	1.500	0.4965-0.4975	0.5615-0.5625*	—	—	0.746-0.747	0.7485-0.7505*	—	—

*Plain Bearing.

CHAPTER 5
CRANKING MOTORS (Cont'd)

Section III

GROUP II—CRANKING MOTORS USING BENDIX DRIVE

	Paragraph
Description	121
Cleaning, inspection, and test	122
Disassembly	123
Cleaning, inspection, and test of parts	124
Repair of parts	125
Assembly of cranking motor	126
Tests	127
Test data and tolerances	128

121. DESCRIPTION.

a. Cranking motors in this group use a Bendix drive with standard mounting and drive arrangement. There may or may not be a center bearing. Some have a magnetic switch mounted on the field frame, others have a manual switch or terminal on the field frame (figs. 133 through 135).

122. CLEANING, INSPECTION, AND TEST.

- a. **Cleaning.** Refer to paragraph 114 a.
- b. **Inspection.** Refer to paragraph 114 b.
- c. **Test.** Refer to paragraph 114 c.

123. DISASSEMBLY.

- a. **Disassembly into Main Subassemblies** (fig. 134).

(1) Detach magnetic switch, where present, by disconnecting connector and removing attaching screws.

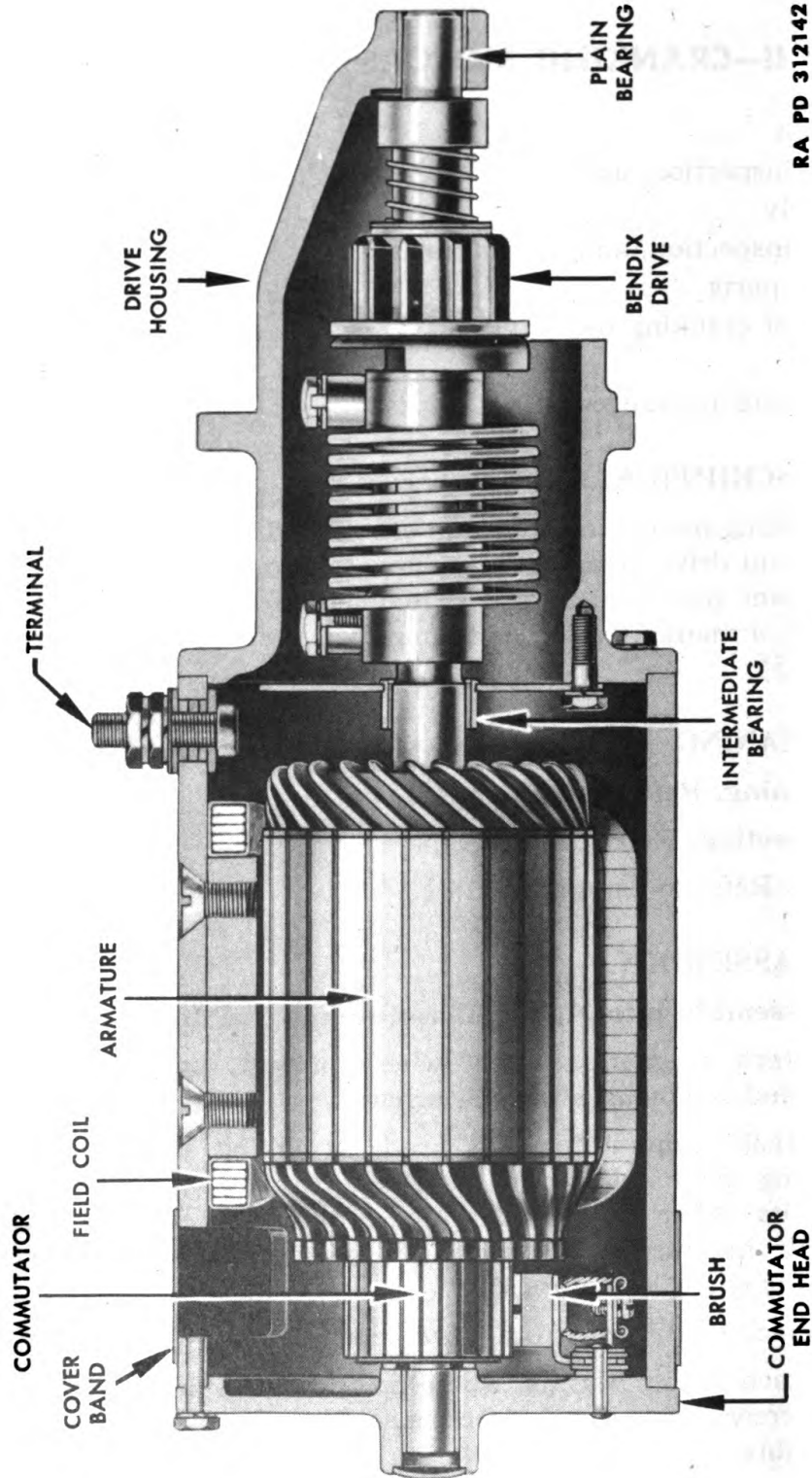
(2) Detach commutator end head by taking off cover band, disconnecting field coil leads from brushes, and then removing through bolts. When necessary, tap the commutator end head lightly with a soft hammer to loosen it. Remove thrust washer, where present, from end of armature shaft.

(3) Detach field frame from drive housing.

(4) Detach center bearing, where present, from drive housing by removing screws, releasing drive housing from armature and Bendix drive assembly.

(5) Place armature in soft jaws of vise, bend down tang of lock washer and unscrew Bendix drive head attaching screw. Slip Bendix

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Figure 133—Sectional View of Cranking Motor with Bendix Drive

GROUP II—CRANKING MOTORS USING BENDIX DRIVE

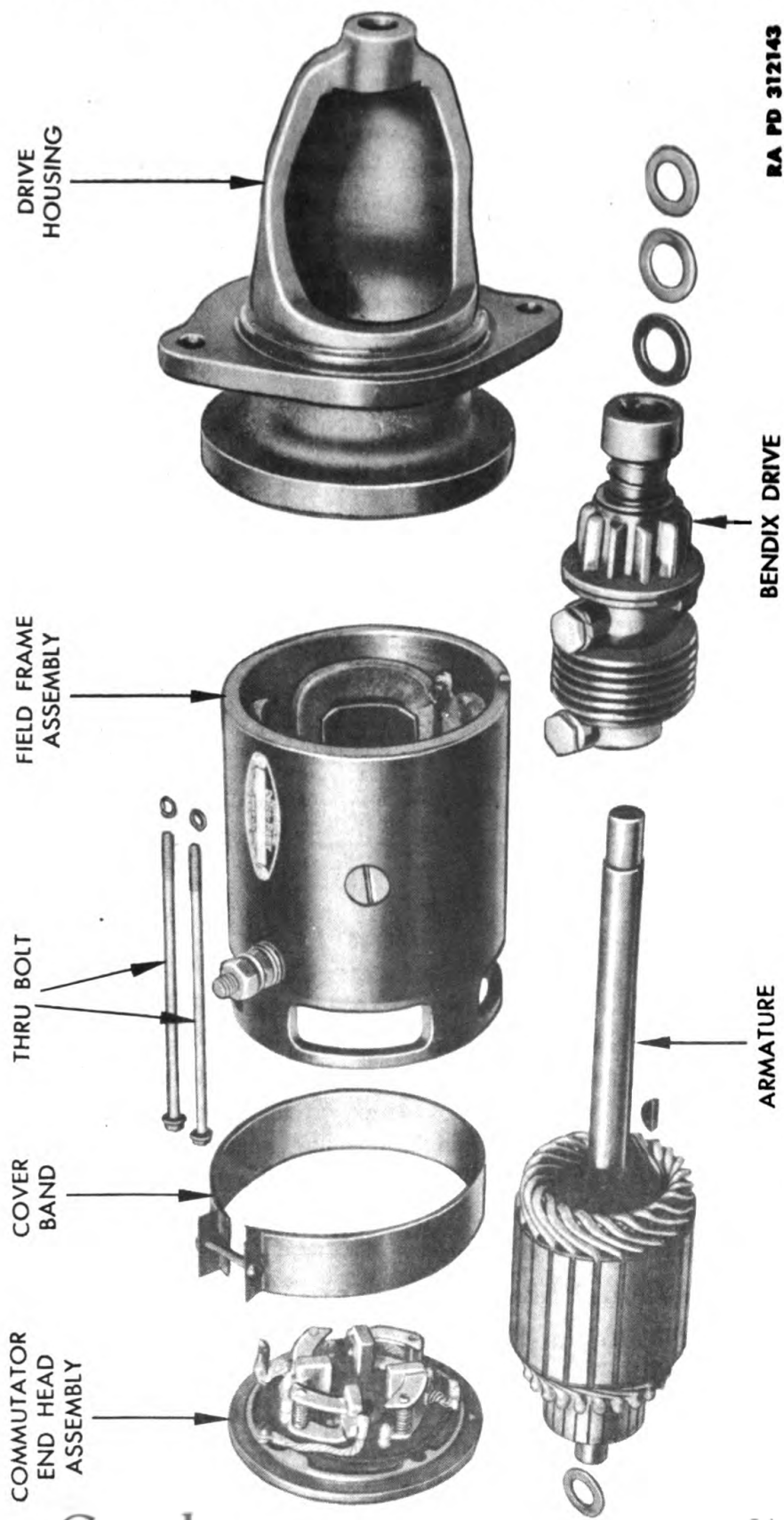


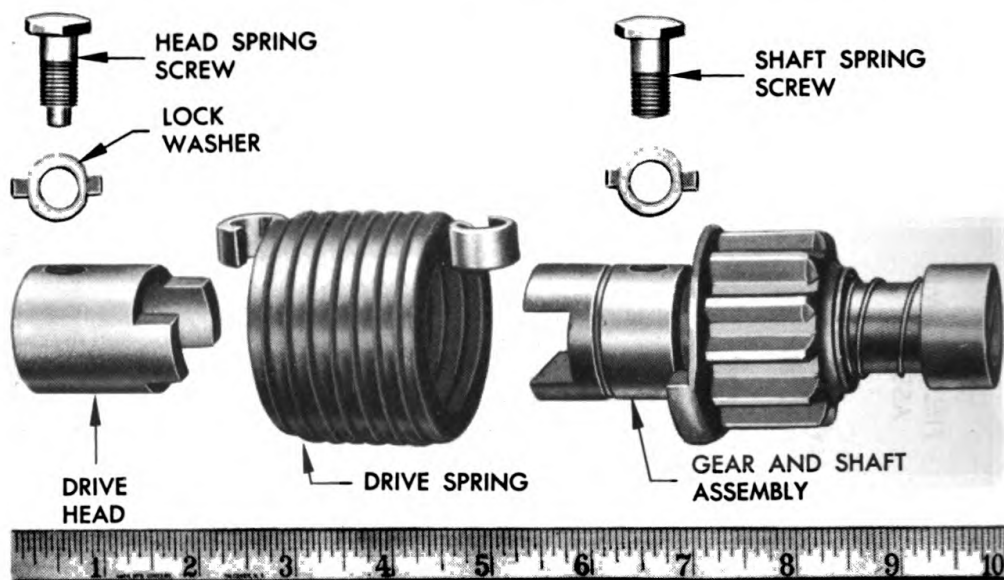
Figure 134—Disassembled View of Cranking Motor with Bendix Drive

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drive off shaft. Remove Woodruff key and slip off center bearing, if present. Disassemble Bendix drive further, if required, by removing other drive spring attaching screw after bending down tang of lock washer. Discard lock washers since the tang lock washer must not be used again.

b. **Disassemble Commutator End Head.** Refer to paragraph 115 b.

c. **Disassemble Field Frame.** Refer to paragraph 115 c.



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Figure 135—Bendix Drive, Disassembled

d. **Disassemble Drive Housing.** Press out old bushing if it is worn and press new bushing into place.

124. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 116.

125. REPAIR OF PARTS.

a. Refer to paragraph 117.

126. ASSEMBLY OF CRANKING MOTOR.

a. **Assemble Field Frame.** Refer to paragraph 118 a.

Assemble Commutator End Head. Refer to paragraph 118 b.

GROUP II—CRANKING MOTORS USING BENDIX DRIVE

c. **Assemble Bendix Drive.** Place armature in soft jaws of vise. Using new tang lock washers, install center bearing, if used, Woodruff keys, and Bendix drive on armature shaft. Secure with attaching screw and tang lock washer. Bend tangs of lock washers up against flat face of screw head.

d. Attach center bearing, where present, to drive housing with screws and lock washers, after placing armature shaft and drive assembly into housing.

e. Place field frame into position, followed by commutator end head. Lift brushes up over commutator as commutator is brought into position. Secure assembly with through bolts. Attach field coil leads to brushes.

f. Attach magnetic switch, where present, with screws and connect connector.

127. TESTS.

a. Refer to paragraph 114 c.

128. TEST DATA AND TOLERANCES.

a. **Test Data.**

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		
			Amps	Volts	RPM	Amps	Volts	Torque ft-lb
737-B	C	24-28	65	5.0	6000	570	3.15	15
737-R	C	24-28	65	5.0	6000	570	3.15	15
737-T	C	24-28	65	5.0	6000	570	3.15	15
737-Z	C	24-28	65	5.0	6000	570	3.15	15
1107012	C	24-28	65	5.0	5000	525	3.37	12
1107059	CC	24-28	65	5.0	5000	525	3.37	12
1107410	C	24-28	65	5.0	6000	570	3.15	15
1107413	C	24-28	65	5.0	6000	570	3.15	15
1107431	C	24-28	65	5.0	6000	570	3.15	15
1107450	C	24-28	65	5.0	6000	570	3.15	15
1107813	C	24-28	65	11.35	6000	450	7.5	15
1107834	C	24-28	65	11.35	6000	450	7.5	15
1107905	C	24-28	60	5.0	6000	600	3.0	15
1108678	C	24-28	65	11.35	6000	450	7.5	15

C Clockwise rotation viewing drive end.

CC Counterclockwise rotation viewing drive end.

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b. Fits and Tolerances.

Nomenclature:

- C.E.—Commutator End
- Comm. Diam.—Commutator Diameter
- D.E.—Drive End
- I.D.—Inside Diameter
- O.D.—Outside Diameter

Model	Comm. Diam. (inch)	Armature Shaft C.E. (inch)	C.E. Head I.D. (inch)	Armature Shaft O.D. at Center Bearing (inch)	Center Bearing I.D. (inch)	Armature Shaft D.E. (inch)	D.E. Head I.D. (inch)
737-B	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
737-R	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
737-T	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
737-Z	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
1107012	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
1107059	1.688	0.5595-0.5605	0.5625-0.5635*	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1107410	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
1107413	1.688	0.5595-0.5605	0.5625-0.5635*	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1107431	1.688	0.5595-0.5605	0.5625-0.5635*	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1107450	1.688	0.5595-0.5605	0.5625-0.5635*	—	—	0.5595-0.5605	0.562-0.564
1107813	1.688	0.5595-0.5605	0.5625-0.5635	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1107834	1.688	0.5595-0.5605	0.5625-0.5635	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1107905	1.688	0.5595-0.5605	0.5625-0.5635*	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564
1108678	1.688	0.5595-0.5605	0.5625-0.5635	0.622-0.623	0.626-0.628	0.5595-0.5605	0.562-0.564

*Grey Iron Bearing.

CHAPTER 5
CRANKING MOTORS (Cont'd)

Section IV

GROUP III—CRANKING MOTORS—HEAVY-DUTY TYPE

	Paragraph
Description	129
Cleaning, inspection, and test	130
Disassembly	131
Cleaning, inspection, and test of parts	132
Repair of parts	133
Assembly of cranking motor	134
Tests	135
Test data and tolerances	136

129. DESCRIPTION.

a. Cranking motors in this group are of the heavy-duty type, used on larger displacement engines. They use heavy-duty type Bendix drives, either of the coil spring or spring-loaded clutch type, and contain a center bearing to help support the armature shaft. Some have a ball bearing in the commutator end. Some use a magnetic switch mounted on the field frame, while others use a manual switch or terminal.

130. CLEANING, INSPECTION, AND TEST.

a. Refer to paragraph 114.

131. DISASSEMBLY.

a. Disassembly Into Main Subassemblies (fig 136).

(1) Detach commutator end head by removing cover band, disconnecting field coil leads from brush holders, and removing commutator end head attaching screws and commutator end head. When necessary, tap commutator end head lightly with a soft hammer to loosen it. Remove thrust washer, where present, from armature shaft.

(2) Remove magnetic switch, where present.

(3) Detach field frame assembly by removing attaching screws and slipping assembly off.

(4) Detach drive housing by removing screws attaching center bearing to drive housing.

(5) Detach Bendix drive and center bearing (par. 123 a (5)).

b. Disassembly of Commutator End Head (fig. 137).

(1) Remove brush attaching screws, lock washers, and brushes.

(2) Detach brush springs by catching straight section with pliers and lifting off.

(3) Remove ball or plain bearing by removing end cover attaching screws and end cover, and pressing out in arbor press. Remove bearing space washer, where present.

c. Disassemble Field Frame (fig. 138). Disassembly procedure is similar to that outlined in paragraph 115 c, except that unit contains six pole shoes, six field coils, and 12 pole shoe screws.

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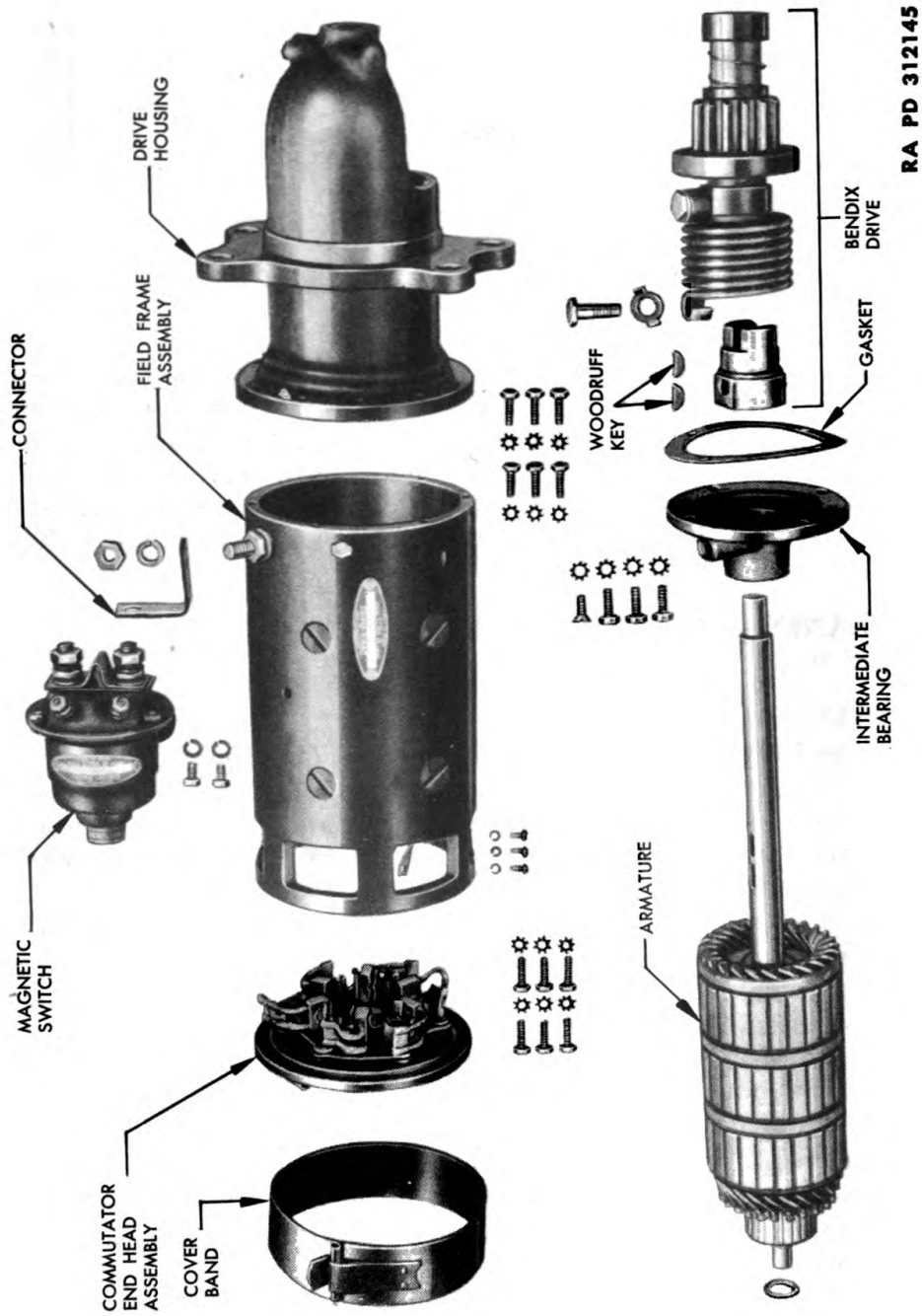


Figure 136—Heavy-duty Type Bendix Drive Cranking Motor Disassembled

GROUP III—CRANKING MOTORS—HEAVY-DUTY TYPE

132. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 116.

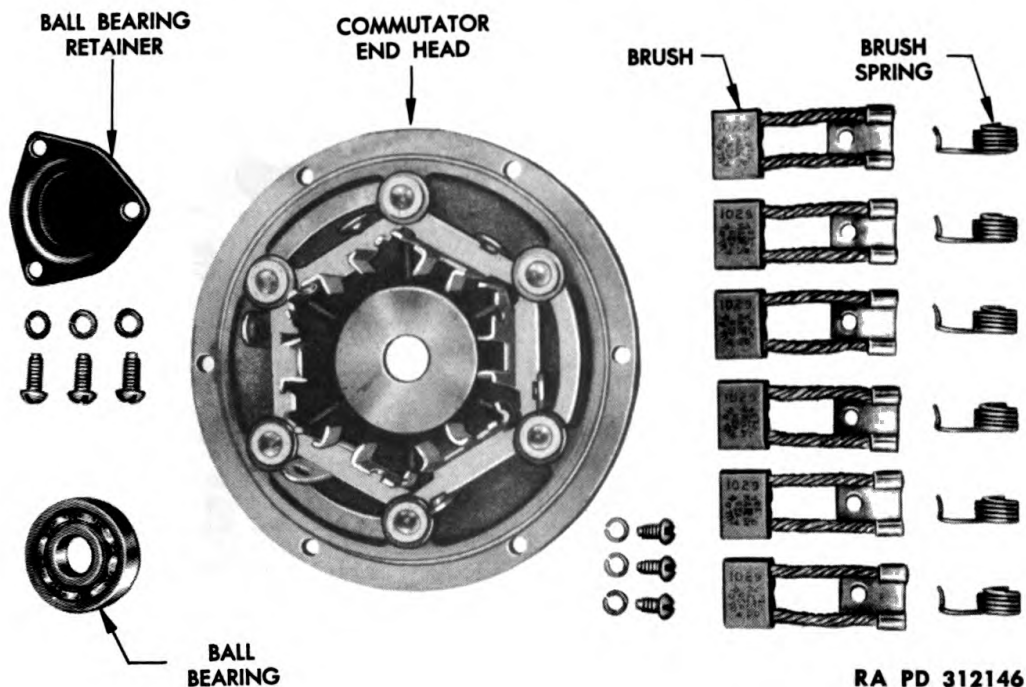
133. REPAIR OF PARTS.

a. Refer to paragraph 117.

134. ASSEMBLY OF CRANKING MOTOR.

a. **Assemble Field Frame.** Refer to paragraph 118 a.

b. **Assemble Commutator End Head.** Install space washer and bearing and secure with cover plate, screws, and lock washers. Install



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**Figure 137—Disassembled View of Commutator End Head
Used in Cranking Motor Shown in Figure 136**

brushes, secure with screws and lock washers and put brush springs in place.

c. **Assemble Drive and Center Bearing to Armature Shaft.** Refer to paragraph 126.

d. Attach center bearing to drive housing with screws and lock washers. Thread safety wire through holes in screw heads and twist ends together.

e. Attach field frame to drive housing with screws and lock washers.

f. Mount magnetic switch, where used, to field frame and connect connector.

g. Attach commutator end head after replacing thrust washer on armature shaft, with screws and lock washers. Connect field coil leads to brush holders and put cover band in place.

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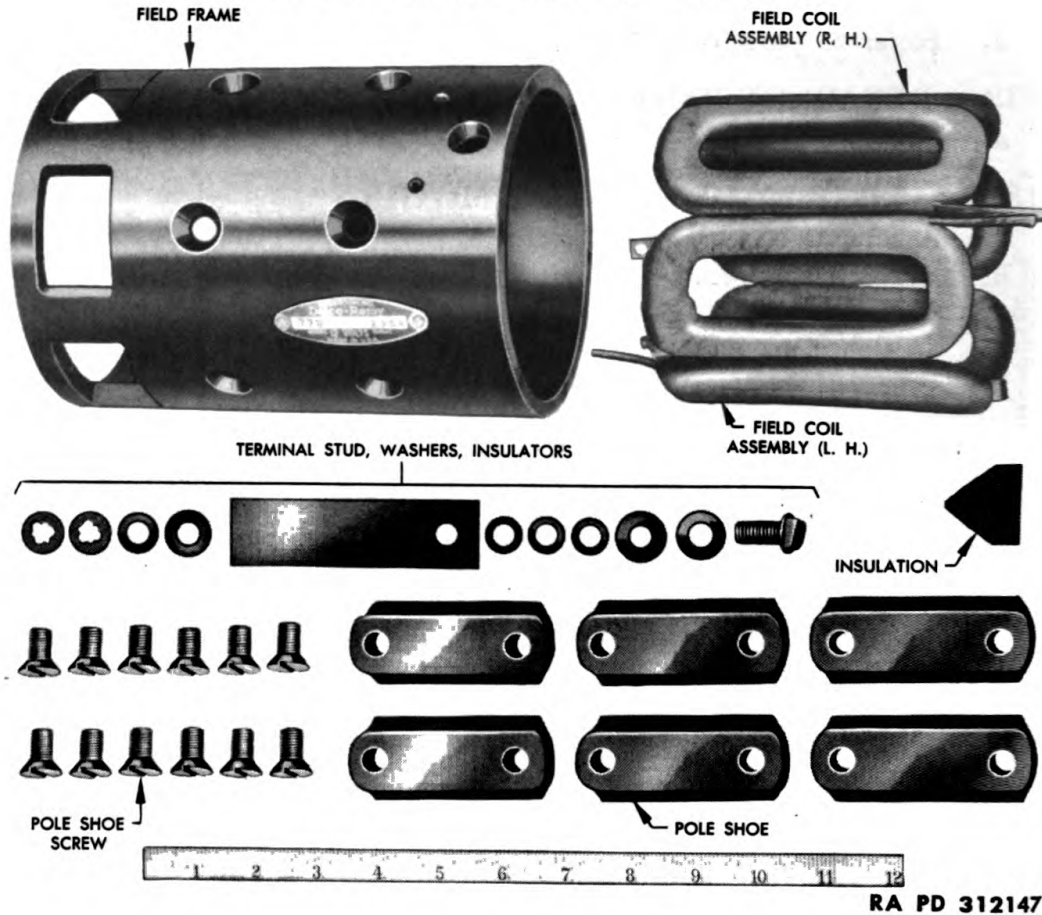


Figure 138—Disassembled View of Field Frame Used in Cranking Motor Shown in Figure 136

135. TESTS.

- a. Refer to paragraph 114 c.

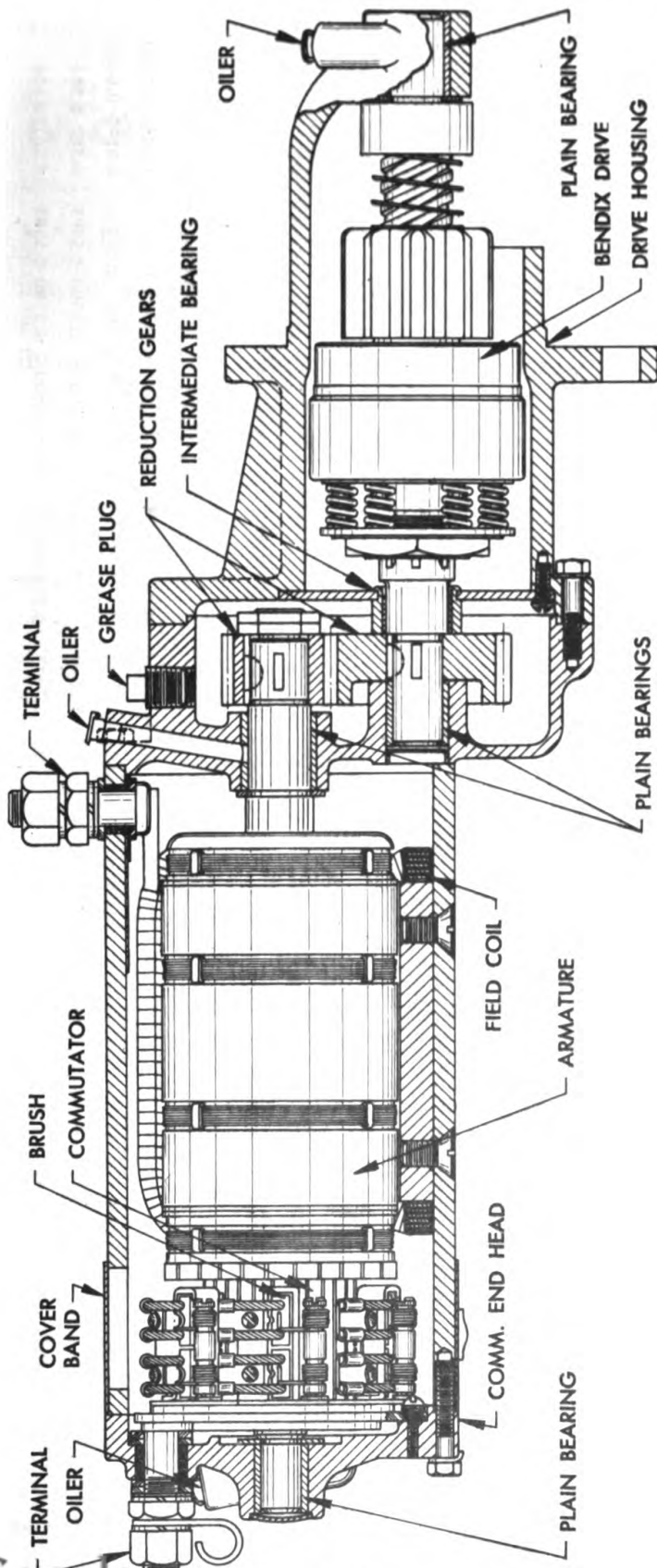
136. TEST DATA AND TOLERANCES.

- a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		
			Amps	Volts	RPM	Amps	Volts	Torque ft-lb
412	C	36-40	80	11.2	4500	670	5.35	32
578	C	36-40	65	12.0	4500	725	4.8	44
590	C	36-40	80	11.2	4500	670	5.35	32
700	C	36-40	70	5.0	3000	500	3.0	19
724	C	36-40	80	11.2	4500	670	5.35	32
733	C	36-40	100	12.0	6000	600	3.0	24
753	C	36-40	65	12.0	4500	725	4.8	44
1108713	CC	36-40	100	11.6	5000	570	2.3	20
1108907	C	36-40	80	11.2	4500	670	5.35	32
1108920	C	36-40	70	5.0	3000	500	3.0	19
1108923	C	36-40	80	11.2	4500	670	5.35	32
1109104	C	36-40	65	12.0	4500	725	4.8	44
1109118	C	32-36	30	32.0	8400	200	7.4	28

C Clockwise rotation viewing drive end.
CC Counterclockwise rotation viewing drive end.

GROUP III—CRANKING MOTORS—HEAVY-DUTY TYPE



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Figure 139—Sectional View of Cranking Motor with Spring-loaded Clutch Bendix Drive

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ELECTRICAL EQUIPMENT (DELCO-REMY)

b. Fits and Tolerances.

Nomenclature:

- C.E.—Commutator End
- Comm. Diam.—Commutator Diameter
- D.E.—Drive End
- I.D.—Inside Diameter
- O.D.—Outside Diameter

Model	Comm. Diam. (in.)	Armature Shaft C.E.—O.D. (in.)	C.E. Ball Bearing I.D.	C.E. Ball Bearing O.D.	C.E. Head I.D. (in.)	Armature Shaft at Center Bearing (in.)	Center Bearing I.D. (in.)	Armature Shaft D.E.—O.D. (in.)	D.E. Head O.D. (in.)
412	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.750-0.752	0.5595-0.5605	0.562-0.563
578	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.746-0.747	0.756-0.759	0.5590-0.5595	0.562-0.564
590	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.757-0.758	0.622-0.623	0.6245-0.6260
700	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.750-0.752	0.5595-0.5605	0.562-0.563
724	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.750-0.752	0.5595-0.5605	0.562-0.563
733	2.125	0.5595-0.5605	—	—	0.562-0.564*	0.746-0.747	0.750-0.752	0.5590-0.5595	0.562-0.564
753	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.746-0.747	0.756-0.759	0.5590-0.5595	0.562-0.564
1108713	2.125	0.5595-0.5605	—	—	0.562-0.564*	0.746-0.747	0.756-0.759	0.5590-0.5595	0.562-0.564
1108907	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.757-0.758	0.622-0.623	0.6245-0.6260
1108920	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.757-0.758	0.622-0.623	0.6245-0.6260
1108923	1.688	0.4990-0.4995	—	—	0.500-0.501*	0.746-0.747	0.757-0.758	0.622-0.623	0.6245-0.6260
1109104	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.746-0.747	0.756-0.759	0.5590-0.5595	0.562-0.564
1109118	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.746-0.747	0.756-0.759	0.5590-0.5595	0.562-0.564

*Bronze Bearing.

CHAPTER 5
CRANKING MOTORS (Cont'd)

Section V

GROUP IV—CRANKING MOTORS—HEAVY-DUTY TYPE
WITH GEAR REDUCTION

	Paragraph
Description	137
Cleaning, inspection, and test	138
Disassembly	139
Cleaning, inspection, and test of parts	140
Repair of parts	141
Assembly of cranking motor	142
Tests	143
Test data and tolerances	144

137. DESCRIPTION.

a. Cranking motors in this group are the same as cranking motors in group III with the exception that they all have a gear reduction (figs. 140 and 141). This requires a different disassembly and assembly procedure.

138. CLEANING, INSPECTION, AND TEST.

a. Refer to paragraph 114.

139. DISASSEMBLY.

a. **Disassembly Into Main Subassemblies** (fig. 140).

(1) Detach commutator end head (par. 131 a (1)).

(2) Detach magnetic switch, where present.

(3) Detach drive housing by removing attaching screws and tapping drive housing away from gear housing with a soft hammer. Remove drive shaft with gear and Bendix drive from drive housing.

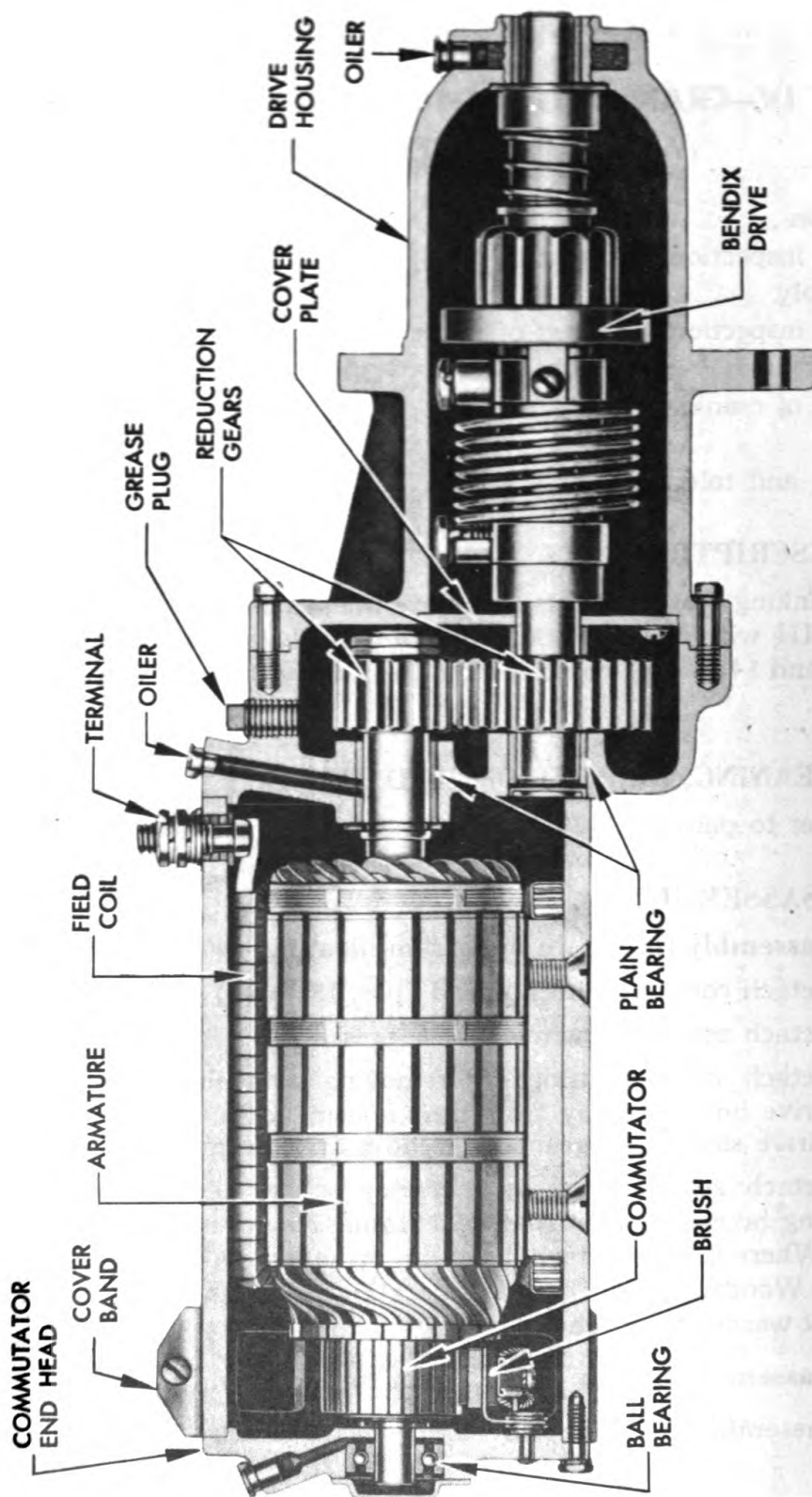
(4) Detach gear housing by removing screws and lock washers and tapping housing away from field frame. Remove armature from housing. Where gear is detachable from armature, take off two nuts, gear and Woodruff keys before separating armature and housing. Slip thrust washer off shaft.

b. **Disassemble Bendix Drive.** Refer to paragraph 123 a (5).

c. **Disassemble Commutator End Head.** Refer to paragraph 131 b.

d. **Disassemble Field Frame.** Refer to paragraph 131 c.

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Figure 140—Sectional View of Heavy-duty Cranking Motor with Bendix Drive and Gear Reduction

**GROUP IV—CRANKING MOTORS—HEAVY-DUTY TYPE
WITH GEAR REDUCTION**

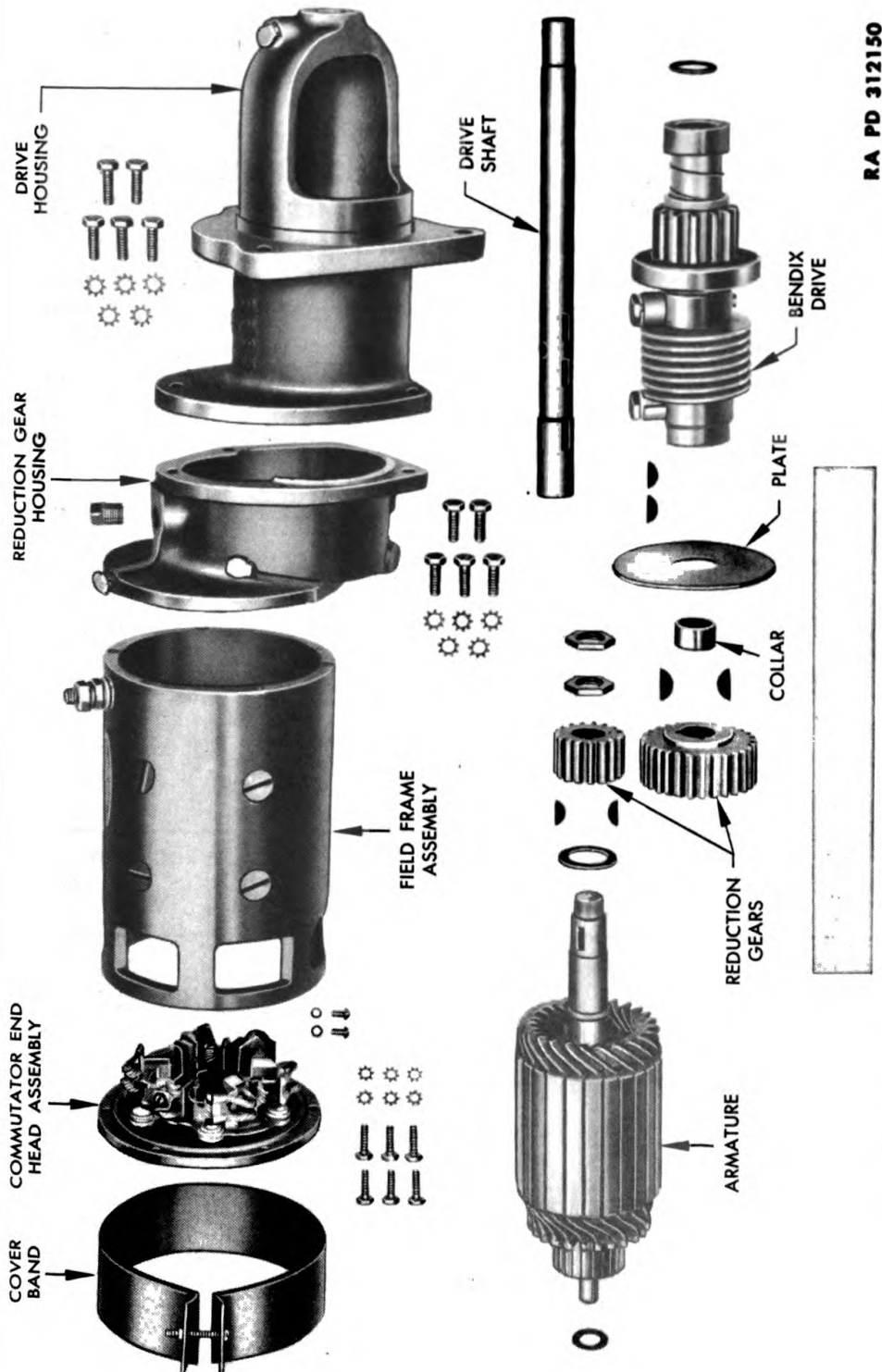


Figure 141—Disassembled View of Cranking Motor Shown in Figure 140

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140. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Refer to paragraph 116.

141. REPAIR OF PARTS.

a. Refer to paragraph 117.

142. ASSEMBLY OF CRANKING MOTOR.

a. Assemble Field Frame. Refer to paragraph 118 a.

b. Assemble Commutator End Head. Refer to paragraph 134 b.

c. Assemble Bendix Drive on Shaft. Refer to paragraph 126 c.

d. Where gear is detached from armature shaft, assemble Woodruff keys, gear and two nuts, after placing armature in gear housing. Be sure thrust washer is on shaft.

e. Assemble gear housing with armature to field frame and attach with screws and lock washers. Be sure thrust washer is on shaft.

f. Attach drive housing to gear housing, after placing shaft with Bendix drive into drive housing, with screws and lock washers.

g. Attach magnetic switch to field frame and connect the connector.

h. Attach commutator end head (par. 134 g).

143. TESTS.

a. Refer to paragraph 114 c.

144. TEST DATA AND TOLERANCES.

a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		Torque ft-lb
			Amps	Volts	RPM	Amps	Volts	
494	C	24-28	70	5.0	2500	600	3.0	28
542	C	34-40	75	8.0	2000	500	3.5	45
572	CC	36-40	75	8.0	2000	500	3.5	45
644	C	36-40	75	8.0	2000	500	3.5	45
713	C	36-40	75	11.25	2400	700	5.0	51
721-G	C	24-28	70	10.0	3000	490	6.5	28
790	C	36-40	75	11.25	2400	700	5.0	51
798	C	36-40	75	8.0	2000	500	3.5	45
1108209	C	24-28	70	5.0	3500	600	3.0	22
1108210	C	24-28	70	5.0	3500	600	3.0	22
1108212	C	24-28	70	5.0	3500	600	3.0	22
1108404	C	24-28	70	10.0	3000	490	6.5	28
1108406	C	24-28	70	10.0	3000	490	6.5	28
1108407	C	24-28	70	10.0	3000	490	6.5	28
1108408	C	24-28	70	10.0	3000	490	6.5	28
1108533	C	24-28	70	10.0	2800	530	6.7	33
1108538	C	24-28	70	10.0	2800	530	6.7	33

C Clockwise rotation viewing drive end.

CC Counterclockwise rotation viewing drive end.

**GROUP IV—CRANKING MOTORS—HEAVY-DUTY TYPE
WITH GEAR REDUCTION**

b. Fits and Tolerances.

Nomenclature:
 C.E.—Commutator End
 Comm. Diam.—Commutator Diameter
 D.E.—Drive End
 I.D.—Inside Diameter
 O.D.—Outside Diameter

Model	Comm. Diam. (in.)	Armature Shaft C.E.—O.D. (in.)	C.E. Ball Bearing I.D. (in.)	C.E. Ball Bearing O.D. (in.)	C.E. Head I.D. (in.)	Armature Shaft O.D. at Gear Housing (in.)	I.D. Gear Shaft for Arm Shaft (in.)	Sub Shaft I.D. (in.)	Sub Shaft O.D. at Gear Housing (in.)	Sub Shaft I.D. (in.)	D.E. Head I.D. (in.)
494	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.8730-0.8735	0.875-0.876	0.687-0.688	0.6850-0.6855	0.6840-0.6845	0.687-0.689*
542	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.8730-0.8735	0.875-0.876	0.687-0.688	0.6850-0.6855	0.6840-0.6845	0.687-0.689*
572	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.8730-0.8735	0.875-0.876	0.687-0.688	0.6850-0.6855	0.6840-0.6845	0.687-0.689*
644	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.8730-0.8735	0.875-0.876	0.687-0.688	0.6850-0.6855	0.6840-0.6845	0.687-0.689*
713	1.688	0.4990-0.4995	—	—	0.500-0.501*	1.2195-1.220	1.222-1.223	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
790	1.688	0.4990-0.4995	—	—	0.500-0.501*	1.2195-1.220	1.222-1.223	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
798	1.688	0.4716-0.4722	0.4721-0.4724	1.2593-1.2598	1.2600-1.2605	0.8730-0.8735	0.875-0.876	0.687-0.688	0.6850-0.6855	0.6840-0.6845	0.687-0.689*
721-G	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
1108209	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.622-0.623	0.626-0.628*
1108210	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
1108212	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.622-0.623	0.626-0.628*
1108404	1.688	0.5595-0.5605	—	—	0.5625-0.5635*	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
1108406	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
1108407	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.622-0.623	0.626-0.628*
1108408	1.688	0.5595-0.5605	—	—	0.5625-0.5635†	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.622-0.623	0.626-0.628*
1108533	1.688	0.5595-0.5605	—	—	0.5625-0.5635*	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*
1108538	1.688	0.5595-0.5605	—	—	0.5625-0.5635*	0.984-0.986	0.992-0.993	0.6245-0.6255	0.622-0.623	0.5595-0.5605	0.562-0.564*

*Bronze Bearing.
 †Grey Iron Bearing.

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CHAPTER 5
CRANKING MOTORS (Cont'd)

Section VI

GROUP V—CRANKING MOTORS USING
OVERRUNNING CLUTCH TYPE DRIVE

	Paragraph
Description	145
Cleaning, inspection, and test	146
Disassembly	147
Cleaning, inspection, and test of parts	148
Repair of parts	149
Assembly of cranking motor	150
Tests	151
Test data and tolerances	152

145. DESCRIPTION.

a. Cranking motors in this group all use the overrunning clutch type drive, operated either manually by a shift lever (fig. 142) or by means of a solenoid (fig. 144). Some have a center bearing, and all use the swivel type brush holder. One model has a reversing switch mounted on the field frame (fig. 143), linked to the shift lever so that the reversing switch is operated every time the engine is started. The reversing switch is connected into the ignition system and reverses the direction of current flow through the distributor contact points every time it operates so that point pitting is balanced out and longer point life is obtained.

146. CLEANING, INSPECTION, AND TEST.

a. Refer to paragraph 114.

147. DISASSEMBLY.

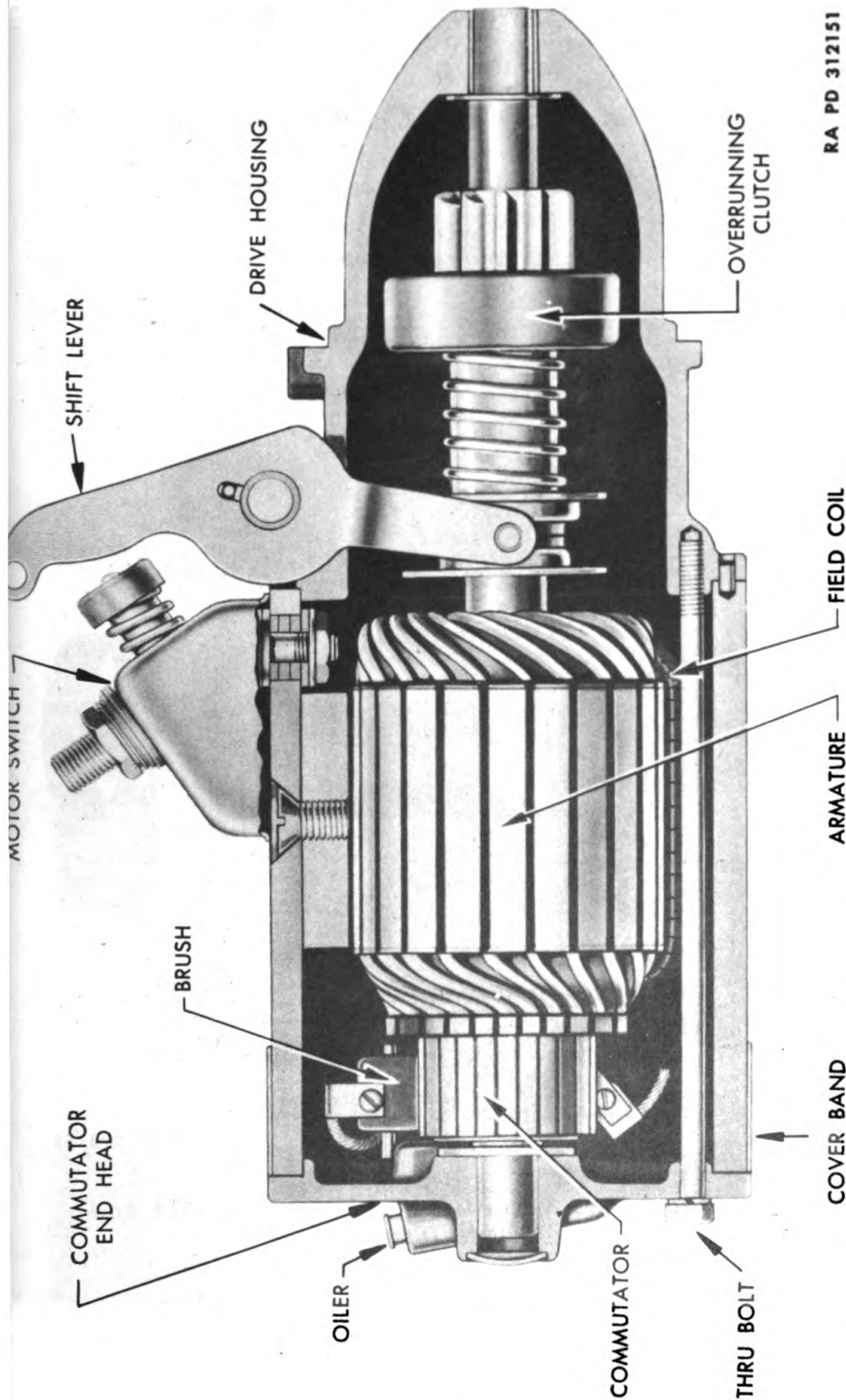
a. **Disassembly Into Main Subassemblies** (figs. 143 and 145).

(1) Where unit has a reversing switch, disconnect link from shift lever, remove screws and take reversing switch off.

(2) Where unit has solenoid, disconnect connector at terminal, unfasten plunger link at shift lever, remove attaching screws and take solenoid off.

(3) Detach commutator end head. Remove cover band, disconnect field coil leads from brush holders by taking out screws, remove through bolts and pull commutator end head from field frame. When necessary, loosen end head with a soft hammer.

**GROUP V—CRANKING MOTORS USING
OVERRUNNING CLUTCH TYPE DRIVE**



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Figure 142—Sectional View of Cranking Motor with Manually Operated Overrunning Clutch

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(4) Detach field frame. When necessary, loosen with a soft hammer.

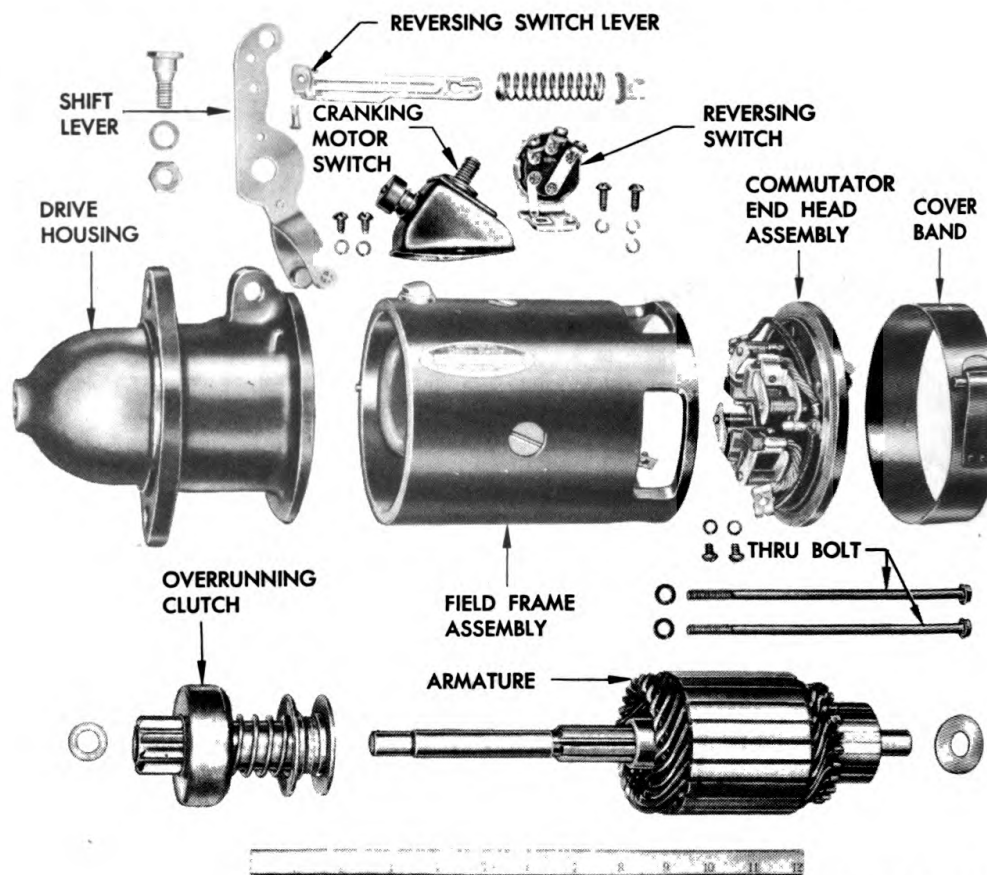
(5) Remove armature.

(6) Where unit has center bearing, detach bearing from drive housing by taking out screws.

(7) Detach shift lever by taking out support stud. Remove overrunning clutch from drive housing.

b. Disassemble Commutator End Head. Refer to paragraph 115 b.

c. Disassemble Field Frame. Refer to paragraph 115 c.



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Figure 143—Cranking Motor with Overrunning Clutch and Reversing Switch, Disassembled

148. CLEANING, INSPECTION, AND TEST OF PARTS.

a. Follow procedure outlined in paragraph 116. The following additional information applies to the overrunning clutch: Never clean the overrunning clutch by any degreasing or dip-cleaning

**GROUP V—CRANKING MOTORS USING
OVERRUNNING CLUTCH TYPE DRIVE**

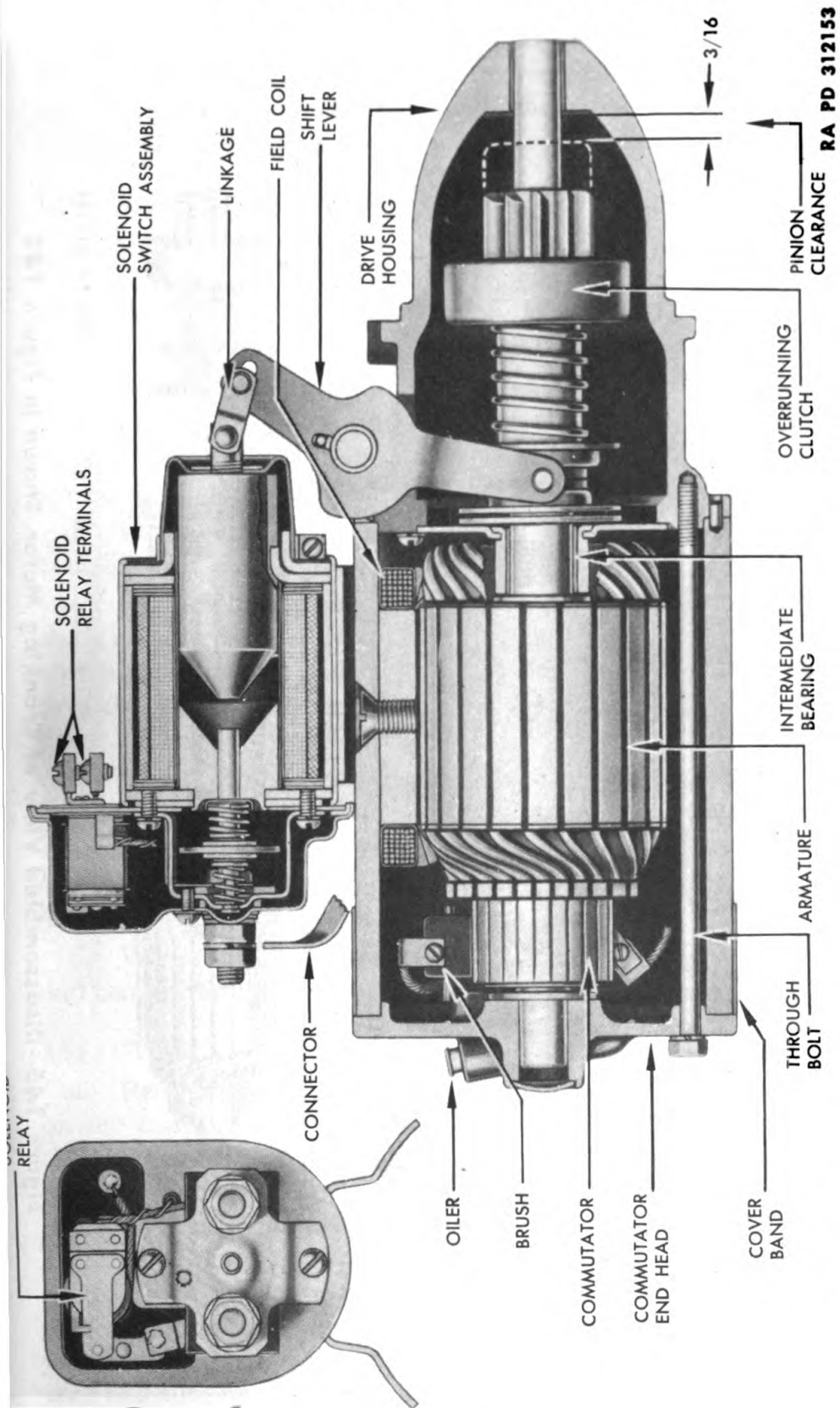
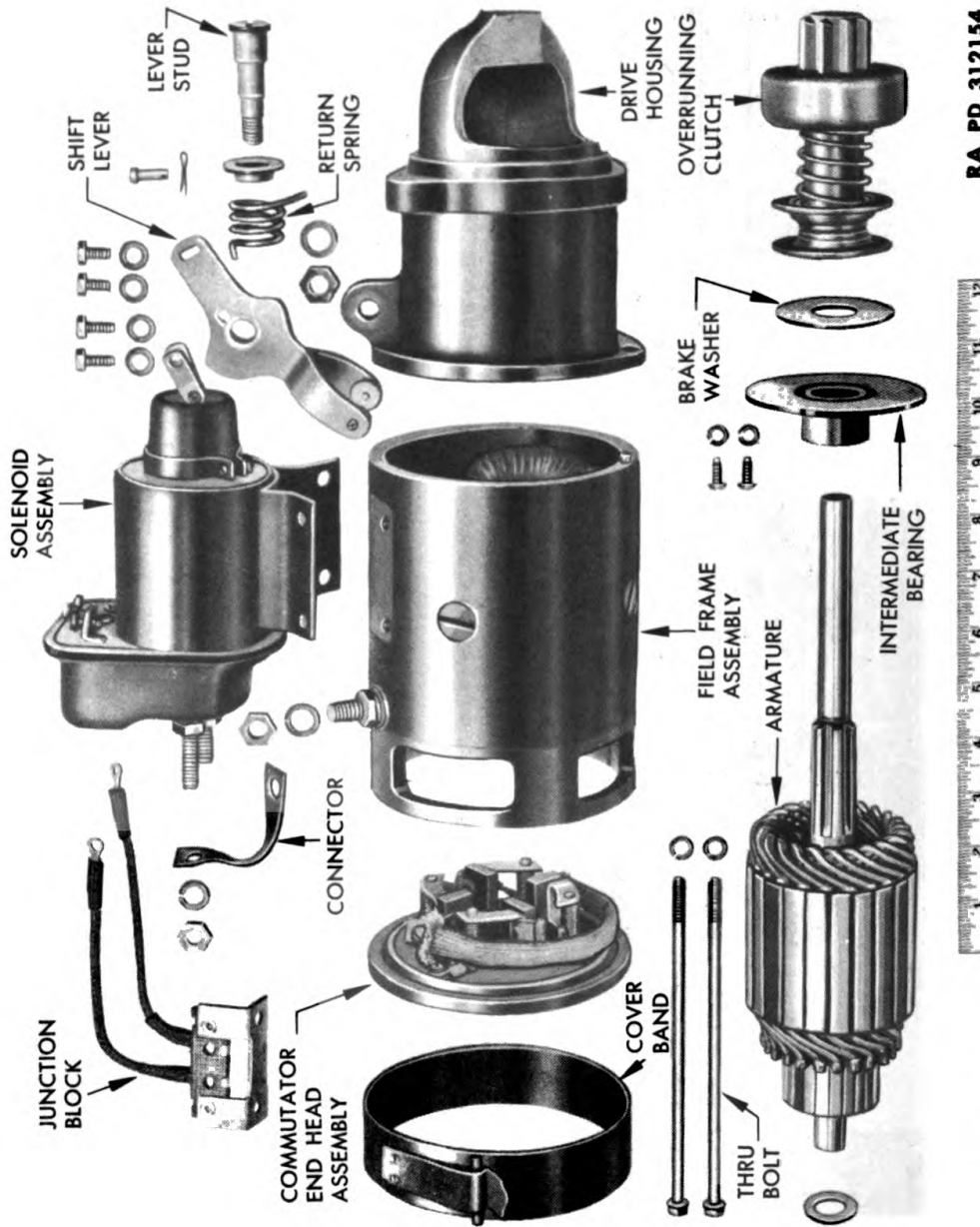


Figure 144.—Sectional View of Cranking Motor with Solenoid-operated Overrunning Clutch

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Figure 145—Disassembled View of Cranking Motor Shown in Figure 144

**GROUP V—CRANKING MOTORS USING
OVERRUNNING CLUTCH TYPE DRIVE**

method as this will remove the lubricant originally packed in the clutch and will render it useless. Wipe clutch with a clean cloth. The drive pinion must rotate freely in the overrunning direction and must not slip in the cranking direction. If the drive pinion turns roughly or slips in the cranking direction, replace the clutch.

149. REPAIR OF PARTS.

- a. Refer to paragraph 117.

150. ASSEMBLY OF CRANKING MOTOR.

- a. **Assemble Field Frame.** Refer to paragraph 118 a.
- b. **Assemble Commutator End Head.** Refer to paragraph 118 b.
- c. Place overrunning clutch in drive housing and install shift lever on housing. The two studs on the ends of the yoke must fit into the overrunning clutch shift collar.
- d. Where unit has center bearing, attach bearing to the drive housing with screws.
- e. Put field frame into position with armature in place. Armature shaft must be inserted into drive housing, through overrunning clutch and into bearing in end of drive housing. Be sure thrust washer, if present originally, is in place between clutch drive pinion and the drive housing.
- f. Attach commutator end head with two through bolts. Connect field coil leads to brush holders with screws and install cover band.
- g. Where unit has solenoid, mount solenoid on field frame, connect connector to terminal, and fasten movable core link at shift lever. Adjust the stud in the solenoid movable core (par. 151).
- h. Where unit has reversing switch, mount switch to field frame and connect link between it and the shift lever.

151. TESTS.

- a. Refer to paragraph 114 c. In addition to other tests to be made on the cranking motor, the solenoid operated unit must be adjusted so the clearance between the pinion and housing, with the pinion in the cranking position, is $\frac{3}{16}$ inch (fig. 144). This measurement is taken by unfastening the connector between the solenoid and motor terminal so the cranking motor will not operate, and then connecting a battery to the solenoid so it will operate and move the shift lever and drive pinion into cranking position. Adjustment is made by unfastening the link between the shift lever and solenoid movable core and turning stud in or out of movable core as required.

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152. TEST DATA AND TOLERANCES.

a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		
			Amps	Volts	RPM	Amps	Volts	Torque ft-lb
1107009	C	24-28	65	5.0	5000	525	3.37	12
1107033	C	24-28	65	5.0	5000	525	3.37	12
1107041	C	24-28	65	5.0	5000	525	3.37	12
1107047	C	24-28	65	5.0	5000	525	3.37	12
1107055	C	24-28	65	5.0	5000	525	3.37	12
1107418	C	24-28	65	5.0	6000	570	3.15	15
1107829	C	24-28	65	11.35	6000	450	7.5	15
1107906	C	24-28	60	5.0	6000	600	3.0	16
1108114	C	24-28	80	10.0	7000	530	6.7	16
1108451	C	24-28	70	5.0	2500	600	3.0	28
1108531	C	24-28	70	10.0	2800	530	6.7	33
1108537	C	24-28	70	10.0	2800	530	6.7	33
1108563	C	24-28	20	23.8	3700	212	19.75	20
1108676	C	24-28	65	11.35	6000	450	7.5	15

C Clockwise rotation viewing drive end.

**GROUP V—CRANKING MOTORS USING
OVERRUNNING CLUTCH TYPE DRIVE**

b. Fits and Tolerances.

Nomenclature:

- C.E.—Commutator End
- Comm. Diam.—Commutator Diameter
- D.E.—Drive End
- I.D.—Inside Diameter
- O.D.—Outside Diameter

Model	Comm. Diam. (in.)	Armature Shaft C.E.—O.D. (in.)		C.E. Head I.D. (in.)	Armature Shaft at Center Bearing (in.)	Center Bearing I.D. (in.)	Gear Housing I.D. Sub Shaft		Sub Shaft Gear Housing	Armature Shaft D.E.—O.D. (in.)		D.E. Head I.D. (in.)
		C.E.—O.D. (in.)	(in.)				Arm Shaft	Sub Shaft		D.E.—O.D. (in.)	(in.)	
1107009	1.688	0.5595-0.5605	0.5625-0.5635	—	—	—	—	—	—	0.4965-0.4975	0.499-0.501	0.499-0.501
1107033	1.688	0.5595-0.5605	0.5625-0.5635	—	—	—	—	—	—	0.4965-0.4975	0.499-0.501	0.499-0.501
1107041	1.688	0.5595-0.5605	0.5625-0.5635	—	—	—	—	—	—	0.4965-0.4975	0.499-0.501	0.499-0.501
1107047	1.688	0.5595-0.5605	0.5625-0.5635	—	—	—	—	—	—	0.4965-0.4975	0.499-0.501	0.499-0.501
1107055	1.688	0.5595-0.5605	0.5625-0.5635	—	—	—	—	—	—	0.4965-0.4975	0.499-0.501	0.499-0.501
1107418	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564
1107829	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564
1107906	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564
1108114	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564
1108451	1.688	0.5595-0.5605	0.5625-0.5635	0.984-0.986	—	0.992-0.993	0.6245-0.6255	0.622-0.623	—	—	—	0.499-0.501
1108531	1.688	0.5595-0.5605	0.5625-0.5635	0.984-0.986	—	0.992-0.993	0.6245-0.6255	0.622-0.623	—	—	—	0.499-0.501
1108537	1.688	0.5595-0.5605	0.5625-0.5635	0.984-0.986	—	0.992-0.993	0.6245-0.6255	0.622-0.623	—	—	—	0.499-0.501
1108563	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564
1108676	1.688	0.5595-0.5605	0.5625-0.5635	0.746-0.747	0.757-0.758	—	—	—	—	0.5595-0.5605	0.562-0.564	0.562-0.564

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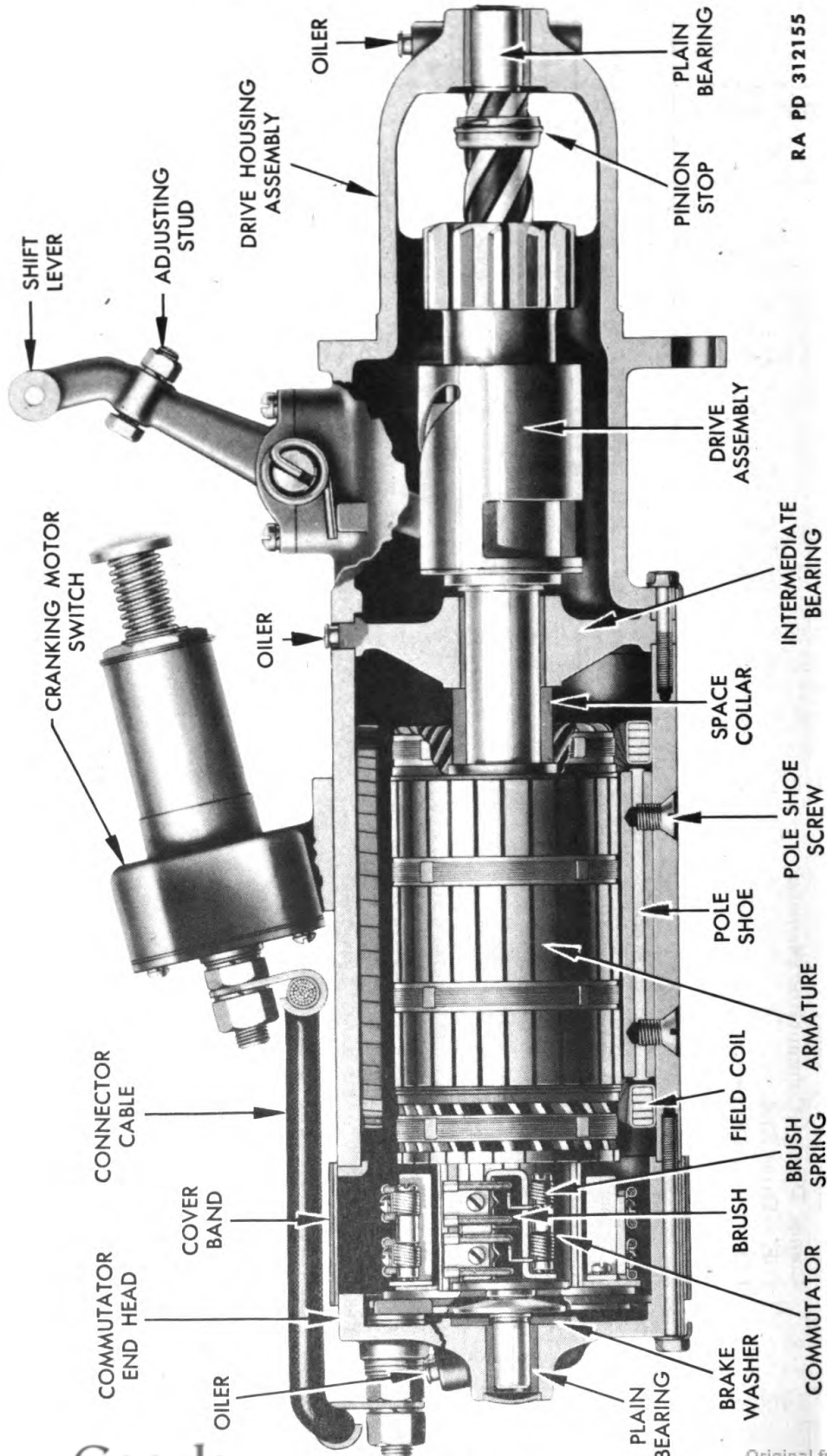


Figure 146—Sectional View of Heavy-duty Cranking Motor
with Manually Operated Drive and Switch

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CHAPTER 5
CRANKING MOTORS (Cont'd)

Section VII

**GROUP VI—CRANKING MOTORS—HEAVY-DUTY TYPE,
USING DYER DRIVE**

	Paragraph
Description	153
Cleaning, inspection, and test	154
Disassembly	155
Cleaning, inspection, and test of parts	156
Repair of parts	157
Assembly of cranking motor	158
Tests	159
Test data and tolerances	160

153. DESCRIPTION.

a. Cranking motors in this group are all heavy-duty type, using the Dyer drive, either manually or solenoid operated. The Dyer drive causes the drive pinion to mesh with the flywheel before the cranking motor switch is closed. This prevents clashing, battering, and burring of teeth. All have a center bearing. The cranking motor has 4 or 6 poles, with either 8 or 12 brushes; brushes being used in pairs.

154. CLEANING, INSPECTION AND TEST.

a. Refer to paragraph 114.

155. DISASSEMBLY.

a. **Disassembly Into Main Subassemblies** (figs. 148 and 149).

(1) Detach cranking motor switch or solenoid switch (whichever is used) by removing nut and lock washer attaching heavy lead to switch terminal. On type with solenoid, remove cotter pin and pin attaching link assembly to shift lever, and unscrew link stud from solenoid plunger. Remove four screws and lock washers, attaching solenoid or switch to field frame and lift off solenoid or switch.

(2) Detach drive housing by bending up tangs on five lock washers and remove five screws and lock washers. Tap housing, with armature, away from field frame with soft hammer. Discard lock washers as they must not be used a second time.

(3) Remove armature with center bearing and Dyer drive assembly from drive end frame after safety wire is cut and four center bearing attaching screws and lock washers are removed. On some types the drive housing attaching screws also hold the center bearing in place (fig. 148).

(4) **DETACH COMMUTATOR END HEAD ASSEMBLY.** Remove cover band by unsnapping catch. Note relationship of brush leads and

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brushes. Disconnect leads from field coil conductors by removing screws and lock washers. Bend up tangs on lock washers and remove six end head attaching screws and lock washers. Tap commutator end head assembly free with soft hammer. Discard lock washers.

b. Disassemble Commutator End Head (figs. 150 through 152).

(1) **REMOVE BRUSH PLATE ASSEMBLY.** Remove nut, lock washer, nut, lock washer, flat and insulating washers, or steel grounding washer from terminal. *NOTE: This terminal is normally insulated but on some units it is grounded to the commutator end head by a steel washer.* Remove three screws, lock washers and flat washers and lift brush plate assembly from commutator end head assembly. Remove from terminal, eight insulating washers (small), and two insulating washers (large).

(2) **DISASSEMBLE BRUSH PLATE ASSEMBLY (fig. 152).** Remove brush lead attaching screws and lock washers, lift up on brush springs and remove brushes. *NOTE: Further disassembly will not be required normally unless insulators, brush holders, springs, or plates require replacement.* Remove insulated brush holders to which were attached field coil leads by unscrewing brush spring pin and brush holder screw. Two springs will come off with each brush spring pin. There are one each lock washers under the pin and screw. Parts will come off in this order: brush holder, thin space plate, brush holder insulating plate, four insulating washers, and (from opposite side after all insulated holders are detached) brass brush holder support plate and brush plate insulating plate. Remove other brush holders from brush plate and stud assembly by unscrewing brush spring pins and brush holder screws. Under each will be a lock washer. Brush holders and thick spacer plate will come off. Two brush springs will come off on pin.

(3) **PRESS OUT COMMUTATOR END HEAD BUSHING.** If the bushing is worn, press out and install a new one. The plug must first be removed. Install new oil wick and oiler as required.

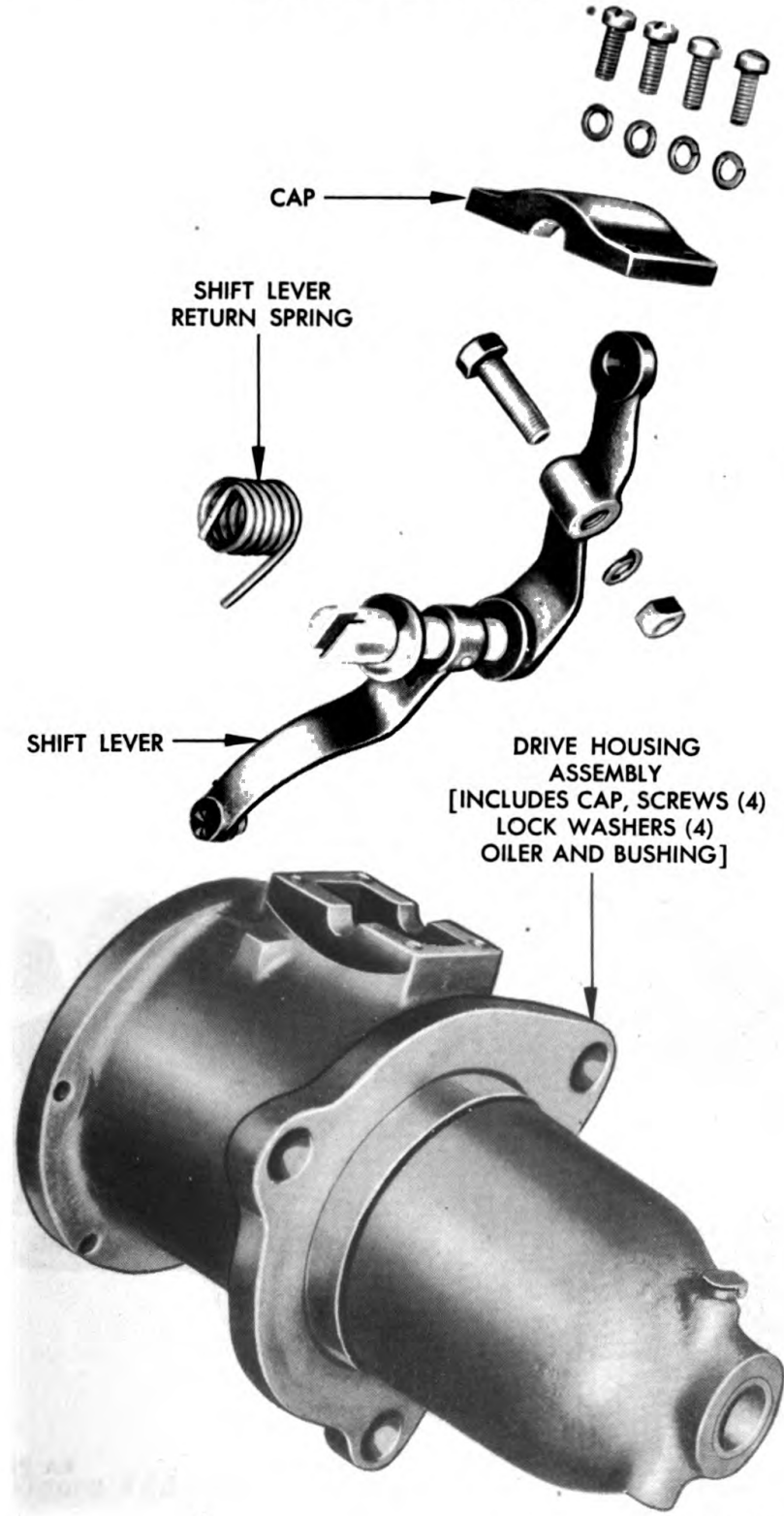
(4) **BRAKE WASHER.** Remove old brake washer and install new one (shellac in place), if necessary.

c. Disassemble Field Frame (figs. 153 and 154).

(1) **DISCONNECT FIELD COILS FROM FIELD TERMINAL.** Disconnect field coils from field terminal by unsoldering leads. Remove terminal stud by removing nut, lock washer, nut, lock washer, flat washer, insulating washers (large), and small insulating washers, insulating strips, washer, and stud. Disconnect leads from frame on type with field coils grounded to frame (fig. 153).

(2) **REMOVE FIELD COILS FROM FRAME.** Remove field coils from frame by removing pole shoe screws with pole shoe screwdriver (fig. 17) and then removing pole shoes and coil assembly. Be careful with coils to avoid bending lead connections or damaging insulation. Note how the long insulating strip and triangular insulating strips (where used) are placed to avoid grounding of the field coil leads against

**GROUP VI—CRANKING MOTORS—HEAVY-DUTY TYPE,
USING DYER DRIVE**

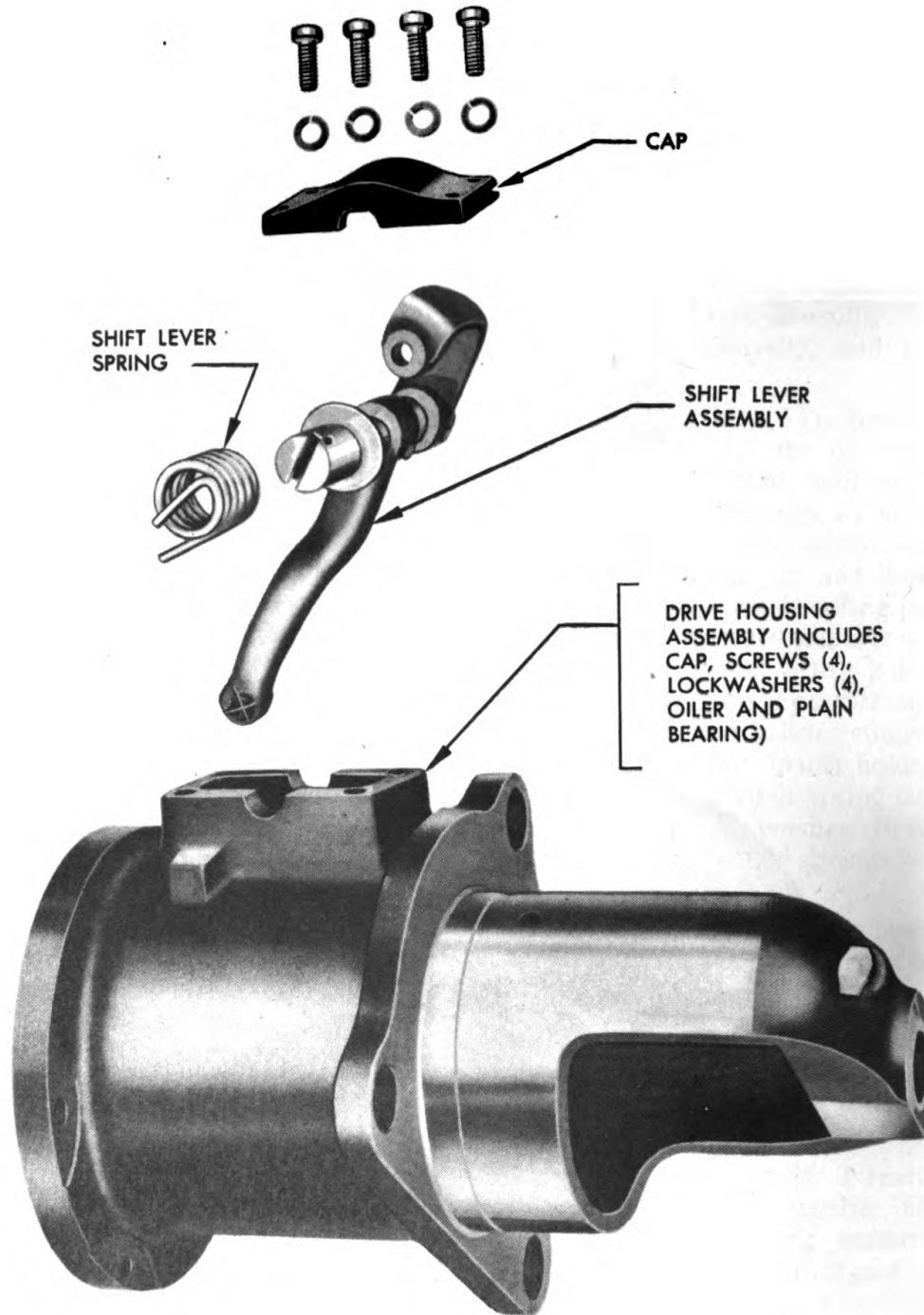


RA PD 312164

**Figure 155—Disassembled View of Drive Housing with
Manually Operated Shift Lever**

TM 9-1825A
155

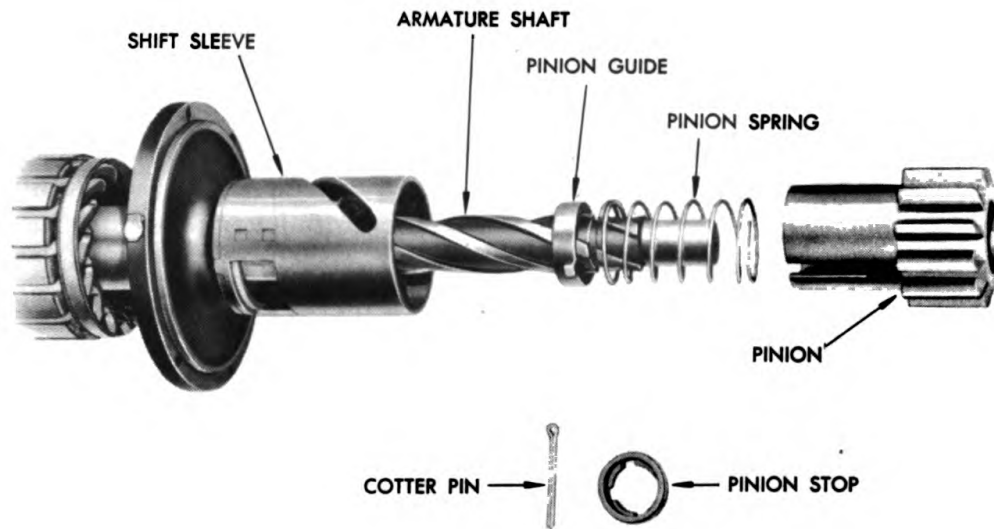
**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**



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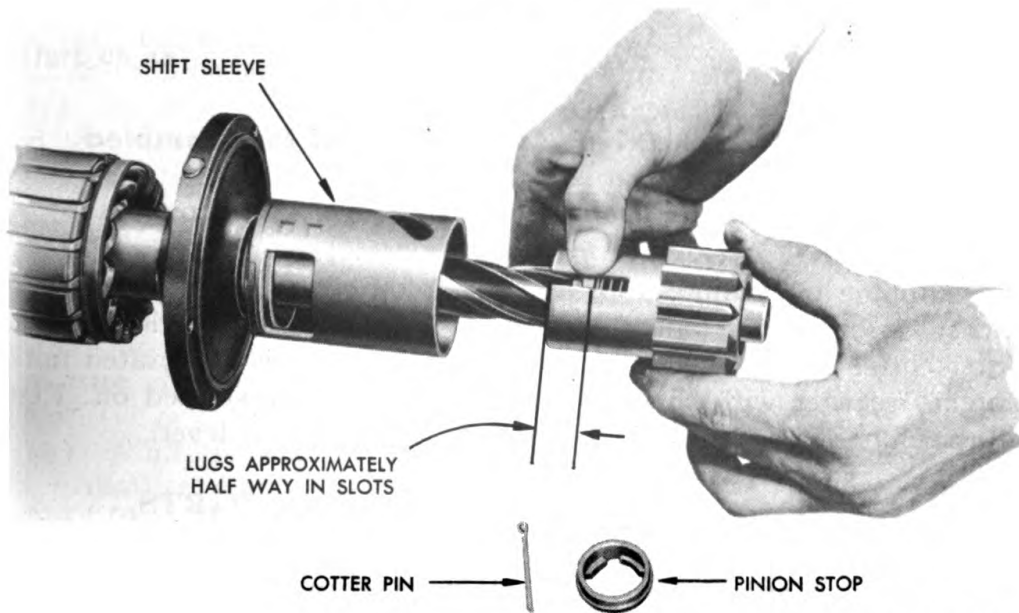
**Figure 156—Disassembled View of Drive Housing with
Solenoid-operated Shift Lever**

**GROUP VI—CRANKING MOTORS—HEAVY-DUTY TYPE,
USING DYER DRIVE**



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Figure 157—Relationship of Dyer Drive Parts with Cotter Pin and Pinion Stop Removed



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Figure 158—Assembly Step of Dyer Drive Assembly

**ORDNANCE MAINTENANCE
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frame. NOTE: Some field coils are varnished and baked in place and cannot be removed. If field coils are baked in place, they are not serviceable separately and defective coils require replacement of field and frame assembly complete.

d. Disassemble Drive Housing (figs. 155 and 156).

(1) Remove shift lever assembly by unscrewing cover attaching screws, and taking off lock washers, cover, shift lever assembly, and shift lever return spring.

(2) Press out bushing if defective, and press in new one. Install new wick and oiler as required

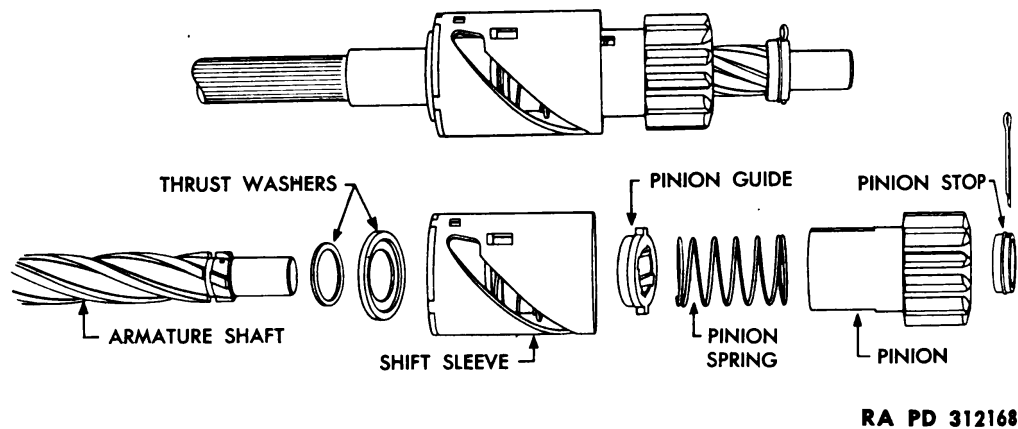


Figure 159—Dyer Drive, Assembled and Disassembled

e. Disassemble Dyer Drive Assembly (figs. 157 through 159).

(1) Remove Dyer drive parts from armature by pulling cotter pin, slipping off pinion stop, pinion, pinion spring, shift sleeve, two thrust washers, center bearing assembly, and collar, in order named. After cotter pin has been removed, pinion stop must be rotated until notches register with shaft splines before it can be slipped off. Rest of assembly slides off easily, by pressing against shift lever.

156. CLEANING, INSPECTION, AND TEST OF PARTS.

a. In addition to procedure outlined in paragraph 116, inspect the armature shaft splines. They must not be worn excessively and the undercut into which the pinion stop fits must provide a snug fit for the pinion stop.

157. REPAIR OF PARTS.

a. In addition to repair procedures outlined in paragraph 117, repair the banding wire on the armature if it has come loose by soldering it after rewrapping with silver solder.

**GROUP VI—CRANKING MOTORS—HEAVY-DUTY TYPE,
USING DYER DRIVE**

158. ASSEMBLY OF CRANKING MOTOR (figs. 146 through 160).

a. Assemble Dyer Drive Assembly (figs. 157 through 159).

(1) Place collar, center bearing plate, plain thrust washer, cupped thrust washer, and shift sleeve on armature shaft. *NOTE: The cupped out section of the cupped thrust washer must face the shift sleeve.*

(2) Assemble the pinion guide, spring, and pinion on the armature shaft.

(a) Place the pinion guide on the armature shaft being careful to note that the lugs on the pinion guide are toward the pinion, but do not twist the pinion guide on the splined armature shaft past the groove, which is about $1\frac{3}{4}$ inches from the end of the armature shaft (fig. 157).

(b) Place the spring on the armature shaft immediately behind the pinion guide.

(c) Put the pinion on the shaft over the spring with the spring compressed in the pinion skirt.

(d) Aline the lugs on the pinion guide with the slots which are cut in the skirt of the pinion.

(e) Hold the pinion guide stationary on the shaft with the thumb and forefinger (fig. 158) and push the pinion onto the shaft with the spring between the two. When the lugs on the pinion guide are about half way into the slots on the pinion skirt, as shown in figure 152, rotate the pinion and pinion guide with respect to the shaft until the pinion splines and shaft splines aline.

(f) Remove the thumb and forefinger from the pinion guide lugs and the twist assembly, consisting of the pinion guide, spring, and pinion on the spline grooves of the armature shaft into the shift sleeve.

(g) Twist on the spline grooves until a click is heard. *NOTE: This click results from the pinion guide dropping into the undercut section of the shaft splines, which locks the entire assembly consisting of the shift sleeve, pinion guide, spring, and pinion into place on the armature shaft, immediately next to the center bearing assembly plate.*

(h) Aline the pinion stop with the spline grooves and twist onto the armature shaft (place the end of the pinion stop which is the farther from the two holes on first). When the stop hits the groove, which is about $1\frac{3}{4}$ inches from the end of the armature shaft, the pinion stop is free to rotate on the shaft. Rotate the stop until the holes in the armature shaft are in line with those in the pinion stop. Insert the cotter pin and bend ends down close around the stop or interference will be encountered between pinion and stop.

b. Assemble Drive Housing (figs. 155 and 156). Place cover on shift lever and assemble to drive end frame with four screws and lock washers. Place spring on shift lever shaft with long tang on drive end frame boss. Catch other end of spring, twist it in a counter-clockwise direction and drop end into slot in end of shaft.

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)****c. Assemble Field Frame (fig. 154).**

(1) **ATTACH FIELD TERMINAL.** Put insulating washer and long and short insulation strips on terminal stud, put stud in position in frame and secure with small insulating washers, large insulating washers, flat washer, lock washer, nut, lock washer, and nut. Slot in stud lead must be alined with frame, and insulating strips so placed as to protect the coil leads from grounding to the frame.

(2) **INSTALL FIELD COILS.** Place field coils in position in frame with pole shoes, insert pole shoe spreader (fig. 25), tighten, and with pole shoe screwdriver (fig. 17), tighten pole shoe screws (two per pole shoe). Solder field coil leads into slot in stud. Long insulating strip and two triangular insulators must be placed so as to protect coil leads from grounding to field frame.

d. Assemble Commutator End Head (figs. 150 through 152).

(1) **ASSEMBLE BRUSH PLATE ASSEMBLY.** Fasten brush holders to brush plate and stud assembly with brush spring pins and brush holder screws. One brush holder is assembled directly above stud, while other two are assembled 120 degrees from it, on six-holder unit, while second holder is 180 degrees from it on four-holder unit. Use pins and screws with short threaded sections. Place thick spacers under holders and lock washers under screws and pins. Install springs on pins with hooked ends toward brush plate and down in holders. Put insulating plate in position on opposite side of brush plate and stud assembly and place brass brush holder support plate next to it. Secure by fastening other brush holders with pins and screws. Two insulating washers go in each screw hole to insulate pins and screws from plate and stud assembly. Place insulating plate, thin spacer washer, brush holder, lock washers, pin and screw above these. Install springs on pins with hooked ends toward brush plate and down in holders. Place brushes in holders and secure the brush lead clips to brush holders with screws and lock washers. Do not install the screws which also fasten field leads to holders.

(2) **ATTACH BRUSH PLATE ASSEMBLY.** Place two insulating washers (large) and several insulating washers (small) on terminal stud. Put brush plate assembly in position in commutator end head and secure with three screws, flat washers, and lock washers. Place on terminal, flat and insulating washers (or stud steel grounding washer), lock washer, nut, lead, lock washer, and nut. *NOTE: This terminal is normally insulated but on some units is grounded to the commutator end head with a steel washer.*

e. Assemble Cranking Motor (figs. 148 and 149).

(1) **ATTACH COMMUTATOR END HEAD AND FIELD FRAME.** Place commutator end head and field frame together in correct relationship so all hinge cap oilers will aline when assembly is completed. Fasten with six screws and lock washers. Use new lock washers. Bend one tang up against screw head. Bend other tang down against frame. Connect field coil leads to brush holders with screw and lock washer. This also fastens brush lead clips to brush holders.

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(2) **PUT ARMATURE IN POSITION.** Place armature, with center bearing and Dyer drive, in position in the drive end housing. Bring in housing at an angle so the stud on the shift lever will engage the slot in the shift sleeve. Establish correct relationship of center bearing and drive housing as determined by oiler on field frame. Secure with four screws and lock washers. Thread 0.032-inch safety wire through holes in screw heads and twist together.

(3) **ATTACH FIELD AND DRIVE HOUSING.** Bring field frame with commutator end and the drive housing with armature together. Lift brushes and cock them in their holders so they will clear commutator. Secure with five screws and lock washers. Use new lock washers. Bend one tang up against screw head and other down against frame.

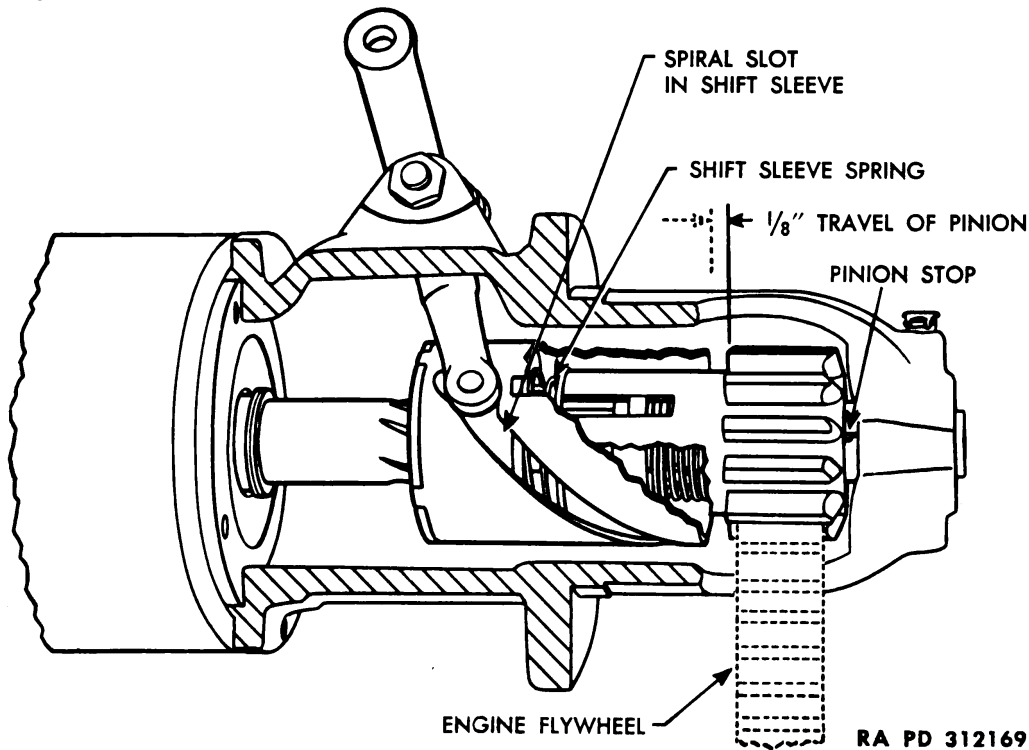


Figure 160—Pinion Travel with Drive Pinion in Cranking Position

(4) **ATTACH CRANKING MOTOR MANUAL OR SOLENOID SWITCH.** Attach manual or solenoid switch to field frame with screws and lock washers. Attach lead clip to cranking motor and solenoid terminal studs with lock washers and nuts. On solenoid-operated unit, screw stud partly into plunger and fasten links to shift lever temporarily with pin and cotter pin. Adjust solenoid or manual type (par. 159).

159. TESTS.

a. In addition to other tests (par. 114 c) to be made on the cranking motor, the pinion travel against the spring with the pinion in the

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

cranking position must be checked and adjustment made if required (fig. 160).

b. On solenoid operated unit, disconnect heavy lead between solenoid and cranking motor so motor will not operate and impose battery voltage on solenoid, helping the shift lever to move by hand. When solenoid completes shift lever movement, push the pinion back and measure travel against pinion spring (fig. 160). Adjust by removing the pin and cotter pin and turning the stud in or out of the solenoid movable core as required. Adjustment must be accurate, since improper adjustment puts sufficient thrust against the pinion guide lugs to break them off.

c. On manually operated type, operate shift lever without battery connected and measure pinion travel from the cranking position as above. Adjust by loosening the lock nut and turning the adjusting stud on the shift lever.

160. TEST DATA AND TOLERANCES.

a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		
			Amps	Volts	RPM	Amps	Volts	Torque ft-lb
702	C	36-40	85	22.0	6000	500	3.0	25
707	C	36-40	85	22.0	6000	500	3.0	25
711	C	36-40	85	22.0	6000	500	3.0	25
739	C	36-40	85	22.0	6000	500	3.0	25
772	C	36-40	85	22.0	6000	500	3.0	25
796	C	36-40	85	22.0	6000	500	3.0	25
815	C	36-40	90	23.3	6800	800	4.35	60
829	C	36-40	100	30.8	8000	700	5.0	56
831	C	36-40	100	30.8	8000	700	5.0	56
833	C	36-40	90	23.3	6800	800	4.35	60
835	C	36-40	100	30.8	8000	700	5.0	56
836	C	36-40	90	23.3	6800	800	4.35	60
905	C	80-96	100	64.0	5000	400	5.0	44
1108704	C	36-40	100	11.6	5000	570	2.3	20
1108705	C	36-40	100	11.6	5000	570	2.3	20
1108714	C	36-40	100	11.6	5000	570	2.3	20
1108730	C	36-40	100	11.6	5000	570	2.3	20
1109306	C	36-40	115	30.7	7250	500	4.3	25
1109312	CC	36-40	85	22.0	6000	500	3.0	25
1109313	CC	36-40	85	22.0	6000	500	3.0	25
1109314	CC	36-40	85	22.0	6000	500	3.0	25
1109315	C	36-40	85	22.0	6000	500	3.0	25
1109317	CC	36-40	85	22.0	6000	500	3.0	25
1109318	CC	36-40	85	22.0	6000	500	3.0	25
1109319	CC	36-40	85	22.0	6000	500	3.0	25
1109320	C	36-40	85	22.0	6000	500	3.0	25
1109321	CC	36-40	85	22.0	6000	500	3.0	25
1109322	CC	36-40	85	22.0	6000	500	3.0	25

C Clockwise rotation viewing drive end.
 CC Counterclockwise rotation viewing drive end.

**GROUP VI—CRANKING MOTORS—HEAVY-DUTY TYPE,
USING DYER DRIVE**

b. Fits and Tolerances.

Nomenclature:

D.E.—Drive End

I.D.—Inside Diameter

C.E.—Commutator End

Comm. Diam.—Commutator Diameter

O.D.—Outside Diameter

Model	Comm. Diam. (in.)	Armature Shaft C.E.—O.D. (in.)	C.E. Head I.D. (in.)	Armature Shaft at Center Bearing	Center Bearing I.D.	Armature Shaft D.E.—O.D. (in.)	D.E. Head I.D. (in.)
702	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
707	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
711	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
739	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
772	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
796	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
815	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
829	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
831	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
833	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
835	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
836	2.313	0.6835-0.6845	0.686-0.688	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
905	3.812	1.121-1.122	1.1235-1.1255	1.737-1.738	1.7485-1.7505	1.121-1.122	1.1235-1.1255
1108704	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1108705	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1108714	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1108730	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109306	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109312	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109313	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109314	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109315	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109317	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109318	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109319	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109320	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109321	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825
1109322	2.125	0.5595-0.5605	0.562-0.564	1.112-1.113	1.122-1.125	0.778-0.779	0.7805-0.7825

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ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 5
CRANKING MOTORS (Cont'd)

Section VIII

GROUP VII—CRANKING MOTORS—HEAVY-DUTY TYPE,
FOR CRANKING RADIAL ENGINES

	Paragraph
Description	161
Cleaning, inspection, and test	162
Disassembly	163
Cleaning, inspection, and test of parts	164
Repair of parts	165
Assembly of cranking motor	166
Tests	167
Test data and tolerances	168

161. DESCRIPTION.

a. The cranking motors in this group are all heavy-duty type, designed for cranking radial engines, and they contain an internal gear reduction from the armature and ending at a meshing jaw that engages a similar jaw in the engine (figs. 161 through 167). Some of these units have an additional support consisting of a strap placed around the field frame. The cranking motor itself, less the gear train and hand cranking device, is similar to group I cranking motors. The hand crank arrangement permits hand cranking of the engine.

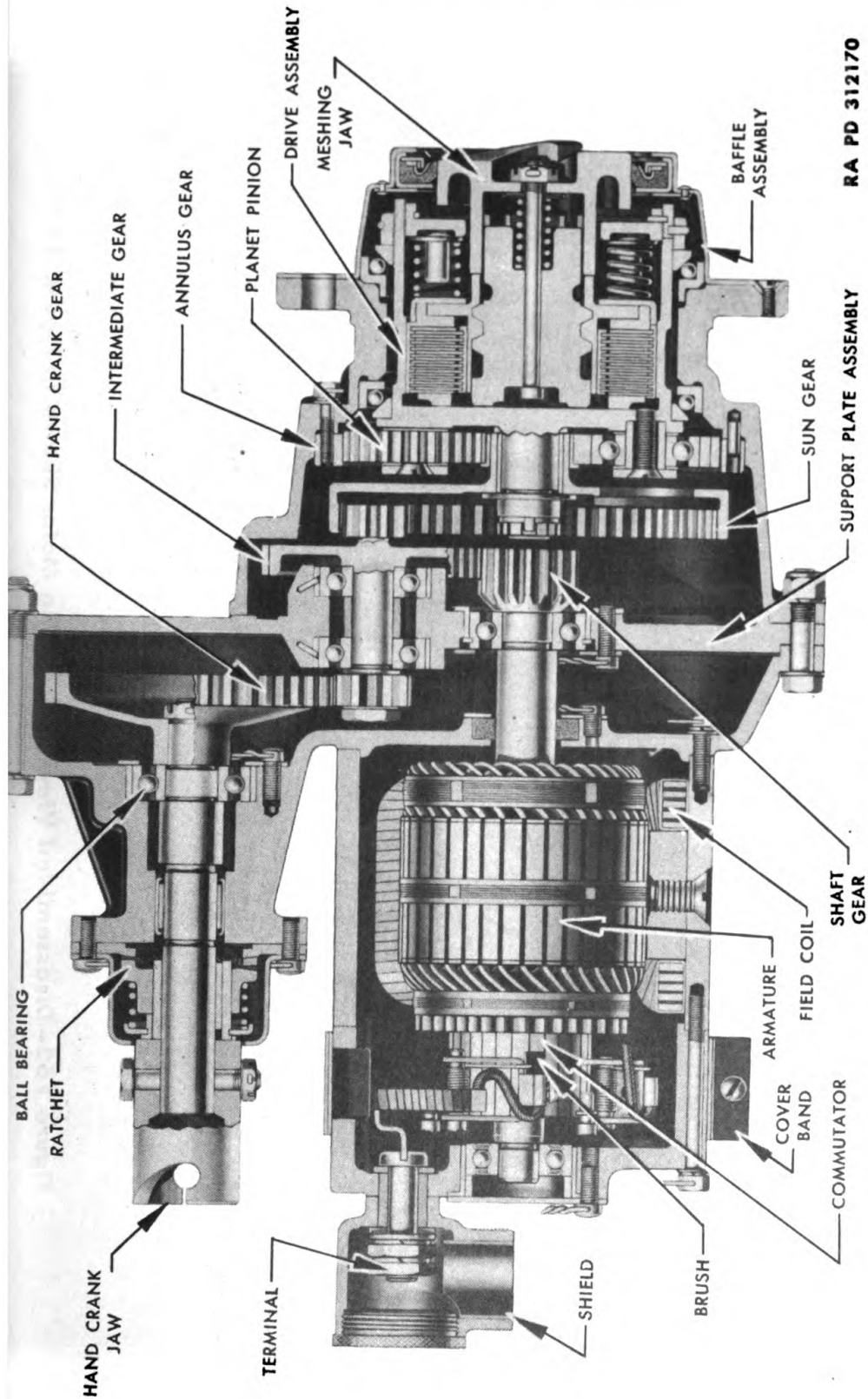
162. CLEANING, INSPECTION, AND TEST.

a. In addition to the standard tests to be applied to the cranking motor as outlined in paragraph 114, the meshing jaw location and the clutch action must be tested.

b. **Meshing Jaw Location.** The meshing jaw, in the retracted position, must be $1\frac{19}{32}$ inches from the mounting flange of the cranking motor, with the baffle plate in position. Adjust by turning the meshing rod nut in or out as required. Secure nut with cotter pin after adjustment. Meshing jaw travel from the retracted position must be $1\frac{1}{32}$ inch.

c. **Clutch Check and Adjustment.** With baffle plate removed, mount cranking motor on test stand and adjust mounting bracket of stand so that the distance between meshing jaw and test stand jaw is $\frac{3}{32}$ inch when meshing jaw is fully retracted. Removal of baffle plate necessitates manual engagement of meshing jaw. Lock brake drum and operate cranking motor for a period of five seconds. Repeat five times at intervals of one minute. If the torque reading on the scale remains constant at 550 foot-pounds within plus or minus

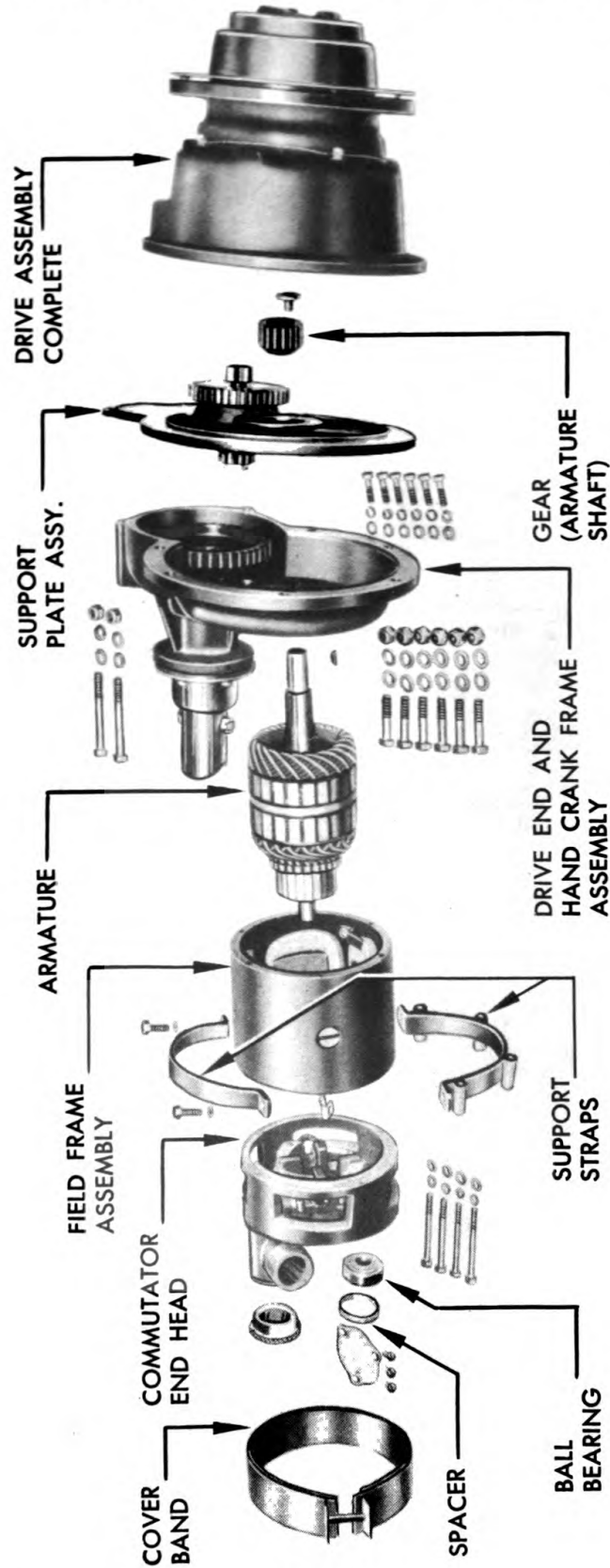
**GROUP VII—CRANKING MOTORS—HEAVY-DUTY TYPE,
FOR CRANKING RADIAL ENGINES**



RA PD 312170

Figure 161—Sectional View of Heavy-duty Cranking Motor with Internal Gear Train

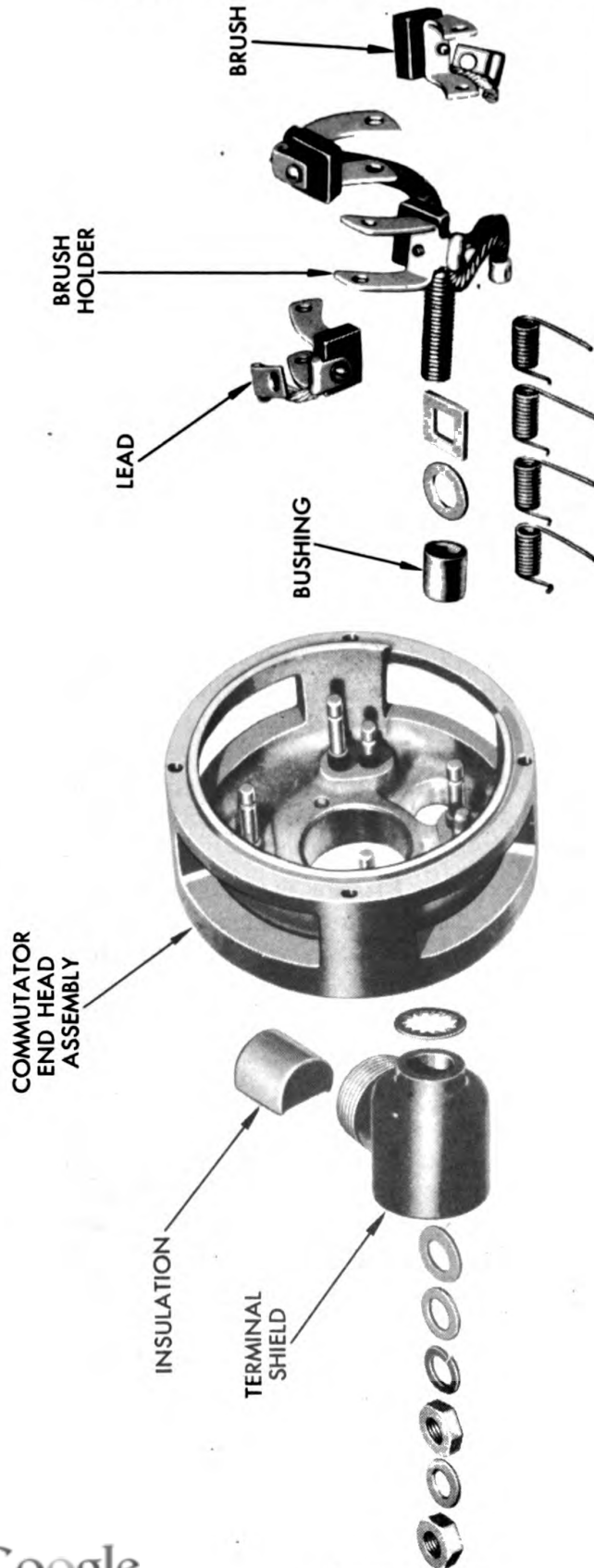
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Figure 162—Disassembled View of Cranking Motor Shown in Figure 161

**GROUP VII—CRANKING MOTORS—HEAVY-DUTY TYPE,
FOR CRANKING RADIAL ENGINES**



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Figure 163—Commutator End Head Disassembled

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20 foot-pounds, clutch adjustment is satisfactory. To adjust, screw clutch adjusting nut out to lower the torque. Screw nut in to raise setting. After the correct setting has been attained, place snap ring in position to lock the nut and allow cranking motor to cool to room temperature and operate cranking motor five consecutive times to determine if setting remains constant. **CAUTION:** *Under no circumstances is cranking motor to be allowed to overheat.*

163. DISASSEMBLY.

a. Disassembly Into Main Subassemblies (figs. 161 and 162).

(1) **DETACH HOUSING AND DRIVE ASSEMBLY COMPLETE.** Mark housing and support so relationship will be established and remove nuts, bolts, and washers attaching housing and drive assembly. Lift housing and drive assembly off.

(2) **REMOVE BEARING AND GEAR SUPPORT ASSEMBLY.** Mark support and frame so relationship is established. Remove armature shaft gear from armature shaft by unscrewing armature shaft gear retainer screw. Screw is staked in place and must be loosened with small drift punch and hammer. Discard screw. If gear does not slip off shaft readily, use a gear puller. Avoid damaging screw threads in end of shaft. Remove Woodruff key. Examine armature shaft for burs. File off any rough spots or burs so shaft will not jam in bearing. Remove two nuts, four washers, and two bolts fastening bearing and gear support assembly to drive end frame and hand crank shaft assembly. Remove bearing and gear support by prying lightly on flange with two small pry-bars and tapping lightly on armature shaft with soft hammer.

(3) **DETACH DRIVE END FRAME AND HAND CRANK SHAFT ASSEMBLY.** Mark frame and field frame so relationship is established. Cut safety wire and unscrew six screws, attaching drive end frame and hand crank shaft assembly to field frame assembly. Six lock washers and six washers will come off with screws. Detach drive end frame and hand crank assembly from field frame assembly.

(4) Lift armature out of field frame.

(5) **SEPARATE COMMUTATOR END FRAME ASSEMBLY AND FIELD FRAME ASSEMBLY.** Mark commutator end frame and field frame to establish relationship. Separate commutator end frame assembly from field frame assembly. Remove cover band, and disconnect brush leads from the field leads by removing two screws and lock washers. Cut safety wire and remove four screws, lock washers, and washers. Separate frames.

b. Disassemble Commutator End Head (fig. 163).

(1) Unscrew terminal shield cap if not already removed.

(2) **DETACH TERMINAL SHIELD.** Unscrew and remove from the terminal stud in the order named, nut, lock washer, nut, lock washer, washer, insulating washer, and terminal shield. Remove fiber sleeve from terminal shield.

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FOR CRANKING RADIAL ENGINES**

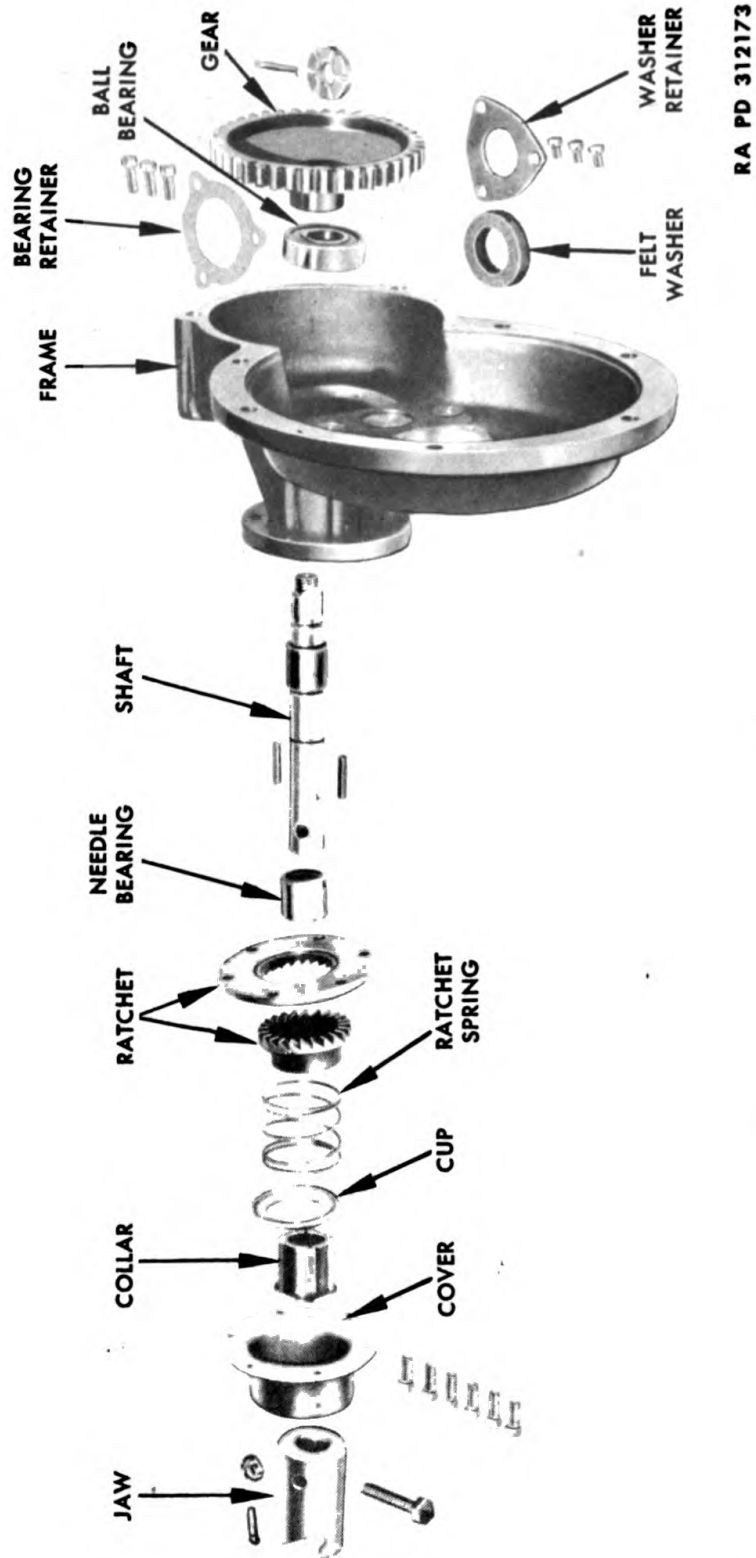


Figure 164—Drive End Frame and Hand Crank Shaft Assembly, Disassembled

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

(3) **REMOVE FOUR BRUSHES.** Unscrew screw from each brush holder. Lock washer will come off with screw. Detach and lift off brushes. Remove two field-to-brush leads. The other two brush leads are connected to the terminal stud.

(4) **LIFT OFF TERMINAL STUD ASSEMBLY.** Lift terminal stud assembly (includes two brush leads) out of commutator end frame. Remove insulating bushing from terminal stud hole in commutator end frame. Remove insulating washer and washer from terminal stud.

(5) **UNHOOK AND REMOVE BRUSH SPRINGS AND HOLDERS.** Unhook hooked end of brush springs from stop. Slip brush springs and brush holders off pins.

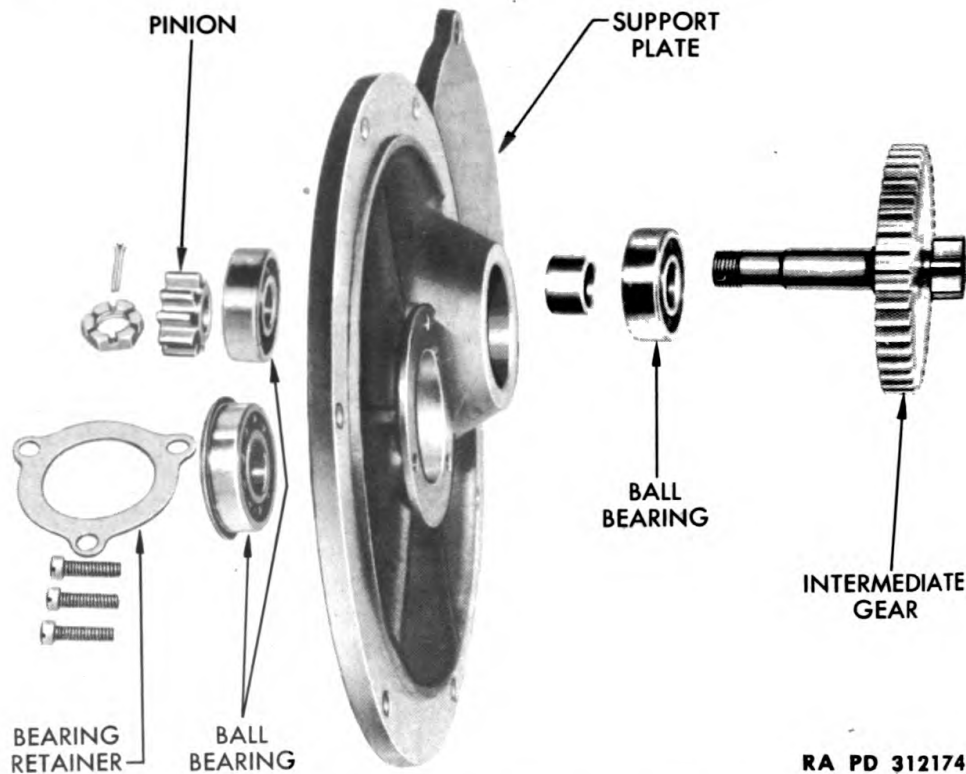


Figure 165—Bearing and Gear Support Assembly, Disassembled

(6) **REMOVE BALL BEARING.** Cut safety wire and remove three screws holding end cover plate to commutator end frame. Remove end cover plate, spacer, and ball bearing.

c. Disassemble Drive End Frame and Hand Crank Shaft Assembly (fig. 164).

(1) **DETACH HAND CRANK JAW.** Remove cotter pin and unscrew castellated nut from bolt. Remove bolt and detach hand crank jaw.

(2) **DISASSEMBLE RATCHET ASSEMBLY.** Cut safety wire and unscrew six screws holding cover to frame. Lift off the following parts in the order named: cover, spline collar, spring cup, spring, movable

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ratchet, and stationary ratchet. Remove two keys from hand crank shaft.

(3) **PRESS OUT HAND CRANK SHAFT.** Remove cotter pin and unscrew round slotted nut from hand crank with special wrench. Set frame up in arbor press with gear side up and press hand crank shaft out of gear and ball bearing. Exert pressure evenly and smoothly. Lift out gear. Slip needle bearing off hand crank shaft.

(4) **REMOVE BALL BEARING.** Cut safety wire and unscrew three screws holding ball bearing retainer plate. Remove plate. Place hand crank shaft through frame into ball bearing in normal position. Support frame with ratchet side up in arbor press and press against hand crank shaft to press out ball bearing. Exert smooth and even pressure.

(5) **REMOVE FELT WASHER.** Cut safety wire and remove three screws holding felt washer retainer plate to frame. Remove retainer plate, and felt washer.

d. Disassemble Bearing and Gear Support Assembly (fig. 165).

(1) **REMOVE INTERMEDIATE GEAR.** Remove cotter pin and unscrew castellated nut from intermediate gear shaft. Slip intermediate gear shaft pinion off. Intermediate gear will slip out of two ball bearings. If necessary, press gear out of bearings in arbor press.

(2) **PULL INTERMEDIATE GEAR SHAFT BEARINGS.** Secure support in soft jaws of vise. Pull intermediate gear shaft ball bearings out of support with puller.

(3) **REMOVE ARMATURE SHAFT BALL BEARING.** Cut safety wire, and remove three screws. Lift off retainer plate, and remove ball bearing.

e. Disassemble Housing and Drive Assembly Complete (fig. 166).

(1) **DETACH BAFFLE PLATE.** Detach baffle plate by unscrewing four screws.

(2) **REMOVE DRIVE ASSEMBLY FROM HOUSING.** Remove lock ring and unscrew ball race adjusting nut with special wrench. Slip ball retainer off. Remove drive assembly from housing. The 120 balls will normally stick to the ball races in the housing. Remove second ball retainer from drive assembly.

f. Disassembly of Housing (fig. 166).

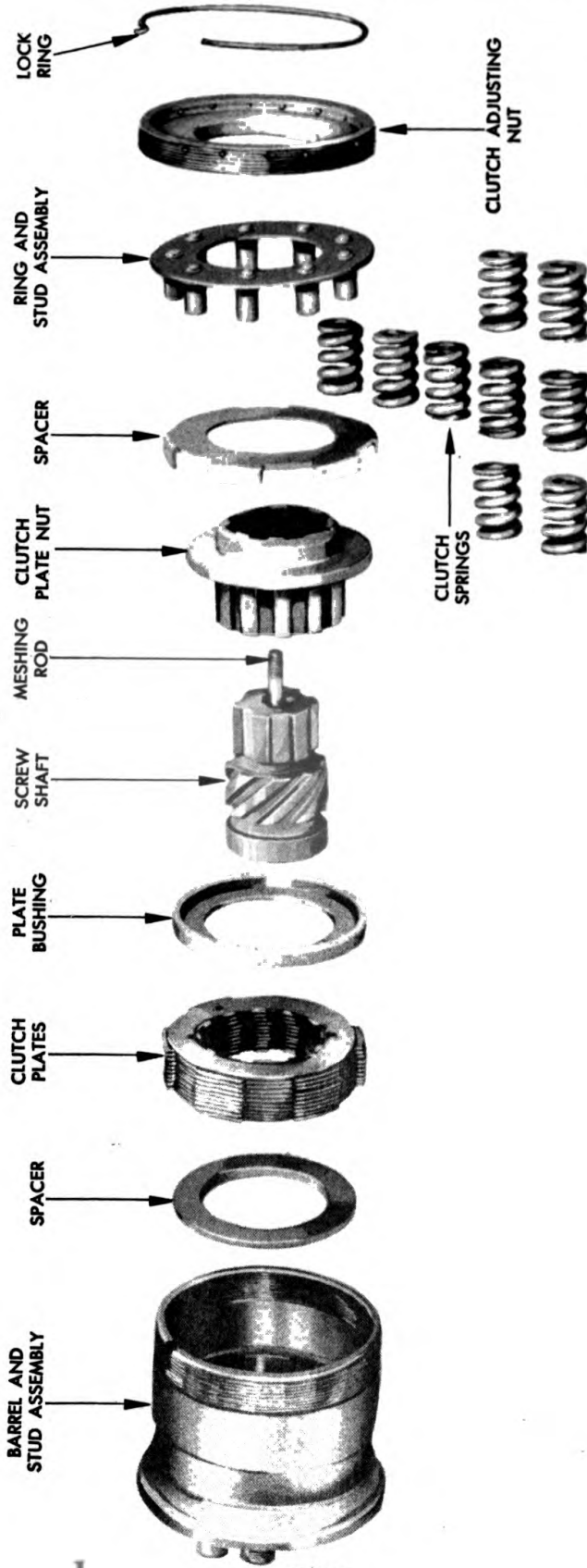
(1) **REMOVE BALL RACES.** Press ball races from the housing if replacement is required. Do not remove otherwise.

(2) **REMOVE ANNULUS GEAR.** Remove the annulus gear assembly from the housing if replacement is required. Cut safety wire and remove four screws, lock washers, and washers. Press out annulus gear in arbor press.

g. Disassemble Drive Assembly (fig. 166).

(1) **REMOVE MESHING JAW, SEAL, AND SPRING.** Remove cotter pin from meshing jaw end of assembly. Unscrew castellated nut. Lift off meshing jaw. Lift off sealing washer, washer, and spring from meshing rod.

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Figure 167—Barrel and Clutch Assembly, Disassembled

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(2) **REMOVE SUN GEAR ASSEMBLY.** Straighten locking tang on lock washer. Unscrew nut from barrel stud with special wrench. Remove lock washer, space collar, space washer, sun gear assembly, and thrust washer.

(3) **DETACH PLANET PINIONS.** Unscrew three screws. The screw heads may be staked in place so that it will be necessary to loosen them with a punch and hammer. If the screws are damaged in removal, they must be replaced. Lift off planet pinion retainer, three washers, three planet pinions (with ball bearings), and three washers.

h. Disassemble Barrel and Clutch Assembly (fig. 167). **NOTE:** *Unless the proper equipment to check and adjust the clutch is available, the barrel and clutch assembly must not be disassembled. In such circumstances, if the clutch operation has been satisfactory, it may be used again. If there is any doubt about its ability to perform satisfactorily until the next overhaul period, it must be replaced as a unit.*

(1) Remove clutch adjusting nut lock ring.

(2) Unscrew clutch adjusting nut, using special wrench. Note exact distance barrel extends beyond nut before removing. On re-assembly, the nut must be screwed into barrel this distance to secure approximate adjustment of clutch.

(3) Lift out stud ring assembly.

(4) Lift out nine springs.

(5) Lift out spring spacer.

(6) Lift out meshing jaw shaft assembly with clutch plate splined nut and bushing. Unscrew nut from shaft and remove bushing from nut.

(7) Lift out clutch plate group. **NOTE:** *Clutch plates must not be separated, as they are serviced as a unit of matched plates. Fasten plates together to retain their original relative positions.*

(8) Remove spacer from barrel.

164. CLEANING, INSPECTION, AND TEST OF PARTS.

a. General. After the cranking motor has been disassembled, inspect, clean, check all parts and replace defective parts as outlined in following paragraphs.

b. Bearings. Thoroughly wash all ball and roller bearings, except the sealed bearing in the commutator end plate, in dry-cleaning solvent, and dry with compressed air. Replace all excessively loose or rough turning bearings. Lubricate all bearings except the sealed bearing with ball and roller bearing grease.

c. Barrel and Clutch Assembly. If the clutch has not been disassembled, wipe the exterior with a cloth moistened with dry-cleaning solvent. **CAUTION:** *Do not immerse in dry-cleaning solvent.* If the clutch is found to need adjustment and has been disassembled, clean all parts. If any plates are worn or scored, use a new pack. Install in the same order as packed because they are

**GROUP VII—CRANKING MOTORS—HEAVY-DUTY TYPE,
FOR CRANKING RADIAL ENGINES**

worn in and matched. The clutch plates must be lubricated with light graphited grease. The springs must be in good condition to provide sufficient compression.

d. Baffle Plate Assembly. If the friction ring is worn, torn, leaking or enlarged to the extent that it is larger than the outside diameter of the meshing jaw, the baffle plate assembly must be replaced. The presence of oil in the housing indicates a worn friction ring seal or meshing rod sealing washer. Replace the defective part. Do not disassemble the baffle plate assembly.

e. Meshing Rod Sealing Washer. Replace the meshing rod sealing washer at every overhaul.

f. Meshing Rod Cup Washer. Replace the cup washer if distorted or cracked.

g. Meshing Jaw Screw Shaft and Clutch Plate Spline Nut. At each overhaul, the screw shaft and splined nut must be magnafluxed, if possible, and closely examined for cracks. Any evidence of cracks is sufficient cause for replacement, to preclude the possibility of subsequent failure.

h. Meshing Jaw. Magnaflux the meshing jaw and replace if cracked. Also replace the jaw if the sharp corner of the leading edge is worn round to a $\frac{1}{16}$ -inch radius.

i. Gears. Replace the gears if the face of the teeth become worn or rolled.

j. Ball Retainers. Replace fitted or grooved ball retainers.

k. Ball Races. Replace fitted or grooved ball races. If the ball races show evidence of creeping in the drive housing, the housing must be replaced. Such evidence would be caused by wear of the housing.

l. Keys. Replace keys which have faces offset $\frac{1}{32}$ inch.

m. Hand Crank Jaw Bolt. Replace hand crank jaw bolt if worn or offset $\frac{1}{32}$ inch.

n. Felt Washer. Replace felt washer if worn or damaged so it fits loosely on armature shaft.

o. Armature. Refer to paragraph 116 b.

p. Fields. Field coils are varnished and baked in place and are not removable. Service field coils by replacing field and frame assembly complete if any defects are found (see par. 116 c).

q. Commutator End Frame. Clean the commutator end frame with dry-cleaning solvent and blow out with compressed air. Make sure that eight pins are tight and in place in the end frame.

r. Insulation. All insulating washers, bushings, and sleeves must be in good condition. If burned, cracked, chipped, or otherwise damaged, replace.

s. Brushes. Brushes worn to $\frac{3}{8}$ inch (original length $\frac{5}{8}$ inch) must be replaced. This is maximum permissible brush wear.

t. Tolerances. Refer to tolerance chart (par. 168).

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165. REPAIR OF PARTS.

- a. Refer to paragraph 157.

166. ASSEMBLY OF CRANKING MOTOR (figs. 162 through 167).

- a. **Assemble Barrel and Clutch Assembly (fig. 167).**

(1) Place spacer in barrel, large face of spacer out.

(2) Put clutch plate group in barrel. Be sure plates have same relationship to each other as when they were removed. If a new plate package is being installed, make sure that they are installed in the same relationship as in the package. Plates are matched and run in at the factory to insure perfect matching of faces. Do not interchange or mix plates, as this will prevent proper operation of clutch.

(3) Assemble meshing jaw shaft, clutch plate splined nut and bushing. Place bushing on splined nut and screw nut on meshing jaw shaft assembly. Place assembly into barrel (fig. 161).

(4) Put spring spacer in place, tangs down, over bushing in barrel.

(5) Assemble stud ring assembly and springs. Place nine springs on studs on stud ring assembly and place assembly into barrel.

(6) Screw in clutch adjusting nut with special wrench to exact distance noted before nut was removed from barrel. This gives approximate adjustment of clutch. Make exact adjustment after assembly is complete.

(7) Snap clutch adjusting nut lock ring into place, with tang through hole.

- b. **Assemble Drive Assembly (fig. 166).**

(1) **ATTACH PLANET PINIONS.** Place three washers on three studs on barrel. Place three planet pinions (with ball bearings) on studs, followed by three more washers. Put planet pinion retainer in place, and secure with three screws. Tighten the screws securely, and stake heads in place by staking over retainer into screw head slots.

(2) **ATTACH SUN GEAR ASSEMBLY.** Place thrust washer (counter-bored side next to barrel), sun gear assembly, space washer, space collar (undercut side down), and locking washer on barrel stud. Secure with nut tightened with special wrench. After tightening, bend matching tang of lock washer into notch on nut.

(3) **INSTALL MESHING JAW.** Place on meshing rod in meshing jaw shaft assembly, spring, washer, and sealing washer. Place meshing jaw on meshing rod and secure with castellated nut. Final adjustment and installation of cotter pin must wait until final assembly is complete.

- c. **Assemble Housing (fig. 167).**

(1) **INSTALL ANNULUS GEAR.** Press annulus gear assembly into housing with studs alined to enter holes in housing. Secure with four screws, washers, and lock washers. Thread 0.032 iron wire through holes in screw heads and twist ends together.

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(2) **INSTALL BALL RACES.** Install ball races in housing with arbor press. Be sure they align and are not forced in at an angle. The two races are not interchangeable, the one with the extra lip goes in the housing from the drive end.

d. Assemble Housing and Drive Assembly Complete (fig. 167).

(1) Place ball retainer on barrel of drive assembly.

(2) Place 60 balls in each ball race in housing. To facilitate this procedure, coat each ball race with special high temperature grease. This will hold balls in place on races.

(3) **INSTALL DRIVE ASSEMBLY.** With drive assembly on bench, slip housing over drive assembly. Be careful not to knock any of balls out of races. Install second ball retainer. Screw ball race adjusting nut on barrel of drive assembly with special wrench. Nut must be tightened to eliminate any appreciable side or end play of drive assembly in housing. To insure proper adjustment, tighten nut until snug and then back off one full hole. The clearance between the barrel adjusting nut and retainer must be at least 0.003 inch. No binding must exist. After adjustment is completed, put adjusting nut lock ring in place with tang in hole.

e. Assemble Bearing and Gear Support Assembly (fig. 165).

(1) **INSTALL ARMATURE SHAFT BALL BEARING.** Place armature shaft ball bearing into support. Ring on bearing outer race must be on same side as retainer plate. Fasten retainer plate to support with three screws. Thread 0.031 iron wire through holes in screw heads and twist ends together.

(2) **INSTALL INTERMEDIATE GEAR SHAFT BEARINGS.** Install intermediate gear shaft bearings in support, in arbor press.

(3) **INSTALL INTERMEDIATE GEAR.** Press intermediate gear shaft through two bearings. If necessary, use an arbor press for this operation. Place intermediate gear shaft pinion in position and secure with castellated nut. Tighten nut to eliminate end play. Gear must not bind after assembly. Install cotter pin.

f. Assemble Drive End Frame and Hand Crank Shaft Assembly (fig. 164).

(1) **INSTALL FELT WASHER.** Install felt washer in frame and secure with retainer plate and three screws. Thread 0.031 iron wire through holes in screw heads and twist ends together.

(2) **INSTALL BALL BEARING.** Press ball bearing into frame with arbor press and secure with ball bearing retainer plate and three screws. Thread 0.031 iron wire through holes in screw heads and twist ends together.

(3) **INSTALL HAND CRANK SHAFT.** Slip hand crank shaft through ball bearing. If it does not pass through ball bearing easily, u

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arbor press to press in place. Put gear in position and with $\frac{5}{8}$ inside diameter collar (3 in. long), press gear onto shaft in arbor press. Support the assembly on the hand crank shaft so that pressure is exerted between gear and shaft and not on bearing. This prevents damage to bearing. Secure gear with round slotted nut, using special wrench. Install cotter pin. Install needle bearing by pressing it in with collar $2\frac{1}{8}$ inches long by $2\frac{1}{32}$ inside diameter by $\frac{13}{16}$ outside diameter.

(4) **ASSEMBLE RATCHET ASSEMBLY.** Place two keys in hand crank shaft keyways. Slip into position in the order named; stationary ratchet, movable ratchet, spring, spring cup (cupped side toward spring), spline collar, and cover, and secure with six screws. Thread 0.031 iron wire through holes in screw heads and twist ends together.

(5) **ATTACH HAND CRANK JAW.** Slip hand crank jaw on hand crank shaft and secure with bolt and castellated nut. Install cotter pin.

g. Assemble Commutator End Frame Assembly (fig. 163).

(1) **INSTALL BALL BEARING.** Install ball bearing in commutator end frame, insert spacer, and secure with end cover plate and three screws. Thread 0.031 iron wire through holes in screw heads and twist ends together.

(2) **INSTALL BRUSH SPRINGS AND HOLDERS.** Install brush springs and holders on pins in commutator end frame. Long straight end of spring rests on back of brush holder, while hooked end hooks over stop pins.

(3) **ASSEMBLE TERMINAL STUD ASSEMBLY TO FRAME.** Place washer and insulating washer on terminal stud. Place insulating bushing in terminal stud hole in commutator end frame and insert terminal stud through bushing. Place terminal shield, insulating washer, washer, lock washer, nut, lock washer, and nut on stud in order named. Press fiber sleeve into terminal shield with notch in position to clear cap. Screw cap into shield. Thread three-inch piece of 0.031-inch iron wire through hole in shield only, and twist ends. After installation, this is to be threaded through three holes in cap to hold cap in place.

(4) **ATTACH BRUSHES AND BRUSH LEADS.** Attach brushes and brush leads with screws and lock washers. Two of the brush attaching screws also attach the leads from the terminal stud to the brush holders. Clips must go under lock washers next to brushes. The other two brush attaching screws also attach the two brush to field coil leads. Smaller clips attach to brushes, next to brushes under lock washers.

h. Assemble Main Subassemblies (fig. 162).

(1) **ATTACH COMMUTATOR END FRAME ASSEMBLY TO FIELD**

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FRAME ASSEMBLY. Place field frame assembly and commutator end frame assembly together so clips of two leads are next to field coil leads. Connect with screws and lock washers. Terminal shield must be on same side as name plate on field frame. Attach with four screws, lock washers, and washers. Thread 0.031 iron wire through holes in screw heads and twist ends together. Place armature into field frame, lift brushes above commutator, and slide armature shaft into bearing in commutator end frame. Release brushes. Place cover band on field frame and secure with screw.

(2) ATTACH DRIVE END FRAME AND HAND CRANK SHAFT ASSEMBLY. Put drive end frame in position on field frame with armature shaft through felt washer. Markings made on frames during disassembly must aline. Attach with six screws, washers, and lock washers. Thread 0.031 iron wire through screw heads, and twist ends together.

(3) ATTACH BEARING AND GEAR SUPPORT ASSEMBLY. Press bearing support in place with armature shaft through bearing. Fasten support to drive end frame with two bolts, four washers, two nuts. Place Woodruff key in keyway in armature shaft and slip gear on shaft. Secure with gear retainer screw and stake screw head.

(4) ATTACH HOUSING AND DRIVE ASSEMBLY. Attach housing and drive assembly to support end frame with 6 bolts, 6 nuts, and 12 washers. Observe markings made on disassembly on housing and frame and make sure they aline on assembly.

167. TESTS.

- a. Refer to paragraph 162.

168. TEST DATA AND TOLERANCES.

- a. Test Data.

Model	Rotation	Brush Tension (oz)	NO-LOAD TEST			LOCK TEST		
			Amps	Volts	RPM	Amps	Volts	Torque ft-lb
1108679	C	32-36	100	11.0	150	240	9.7	150§
1108681	C	32-36	50	23.0	160	130	21.6	150‡
1108682	C	32-36	100 max.	11.0	120	270	9.4	150†
1108683	C	32-36	50 max.	23.0	120	125	21.5	150*
1108684	C	32-36	100 max.	11.0	120	270	9.4	150†
1108685	C	32-36	50 max.	23.0	120	125	21.5	150*

- * Running torque at 65 rpm (minimum).
- † Running torque at 58 rpm (minimum).
- ‡ Running torque at 74 rpm
- § Running torque at 60 rpm
- C Clockwise rotation viewing drive end.

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b. Tolerances.

	Fit
C. E. ball bearing in housing	0.0007L-0.0001T
C. E. ball bearing on armature shaft	0.0008L-0.000T
Crank gear on crankshaft	0.0005T-0.001L
Crankshaft ball bearing in housing	0.0007L-0.0003T
Crankshaft roller bearing bore in housing	0.812-0.813
Crankshaft O.D.	0.6240-0.6245
Spline collar ratchet	0.003L-0.0061
Crank collar on crankshaft	0.0005L-0.0020L
Crank collar bolt in crankshaft	0.001L-0.005L
Intermediate shaft ball bearings in support	0.0007L-0.0001T
Ball bearing on intermediate gear shaft	0.0007L-0.0000T
D. E. ball bearing on armature shaft	0.0008L-0.0001T
D. E. ball bearing in bearing support	0.0002L-0.0011L
Planetary pinion ball bearing on stud	0.0002L-0.0007L
Front ball race in housing	0.0000L-0.003T
Rear ball race in housing	0.0015L-0.002L
Bushing in sun gear	0.0015L-0.003T
Ball rings on barrel	0.001L-0.003L
Spline nut bushing on spline nut	0.001L-0.004L
Sun gear thrust washer, small (thickness)	0.060-0.064
Sun gear thrust washer, large (thickness)	0.062-0.066
Sun gear on barrel shaft	0.0005L-0.0015L

L—Loose.
T—Tight.

CHAPTER 6 MISCELLANEOUS

Section I

IGNITION COILS

	Paragraph
Construction and function	169
Cleaning, inspection, and test	170

169. CONSTRUCTION AND FUNCTION.

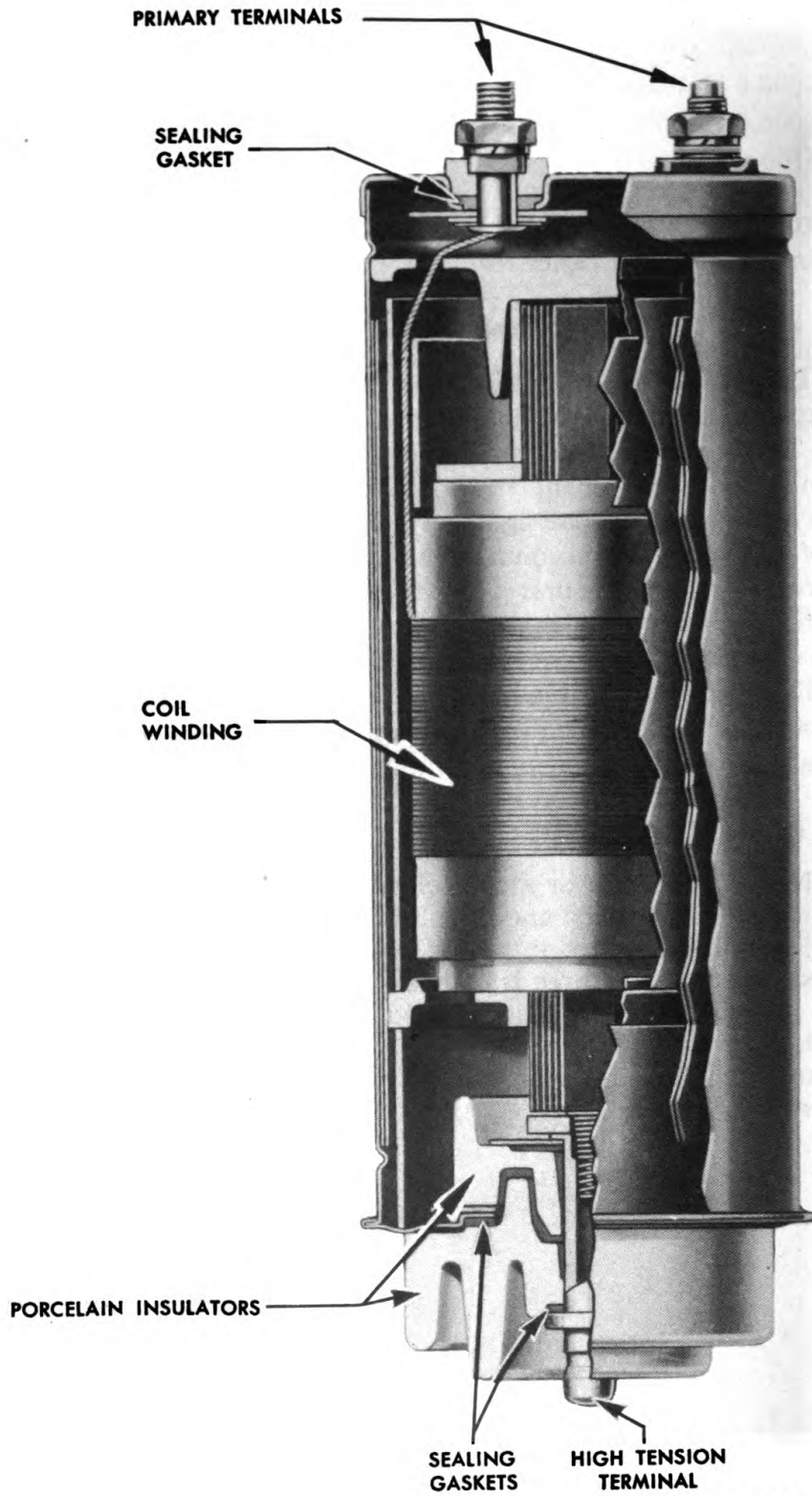
a. Ignition coils are essentially transformers that transform or step up the voltage in the electrical system to as much as 20,000 volts. This high voltage is delivered by the ignition coil through the ignition system to the spark plugs so the fuel-air mixture in the cylinders is ignited. The ignition coil (figs. 168 through 170) consists of primary and secondary windings, wound on the same core, and protected by an outer case. Some coils (figs. 168 and 170) are hermetically sealed so that moisture cannot enter the coil case to reduce insulation resistance and cause short circuits or grounds. The only disassembly possible in ignition coils is the removal and replacement of the lead attaching screws and, on some coils, the removal and replacement of the mounting bracket.

170. CLEANING, INSPECTION, AND TEST.

a. Never dip-clean or steam-clean ignition coils since this causes injury to the windings and insulation, and produces early failure. Clean by wiping with a clean, dry cloth. Inspect terminals for stripped or crossed threads. Check coil head for cracks, chipped places or burned paths that would allow high tension leakage to ground. Note the condition of the coil case, making sure that it is not punctured or that the seams have not opened up. Test the coil on coil tester.

TM 9-1825A
170

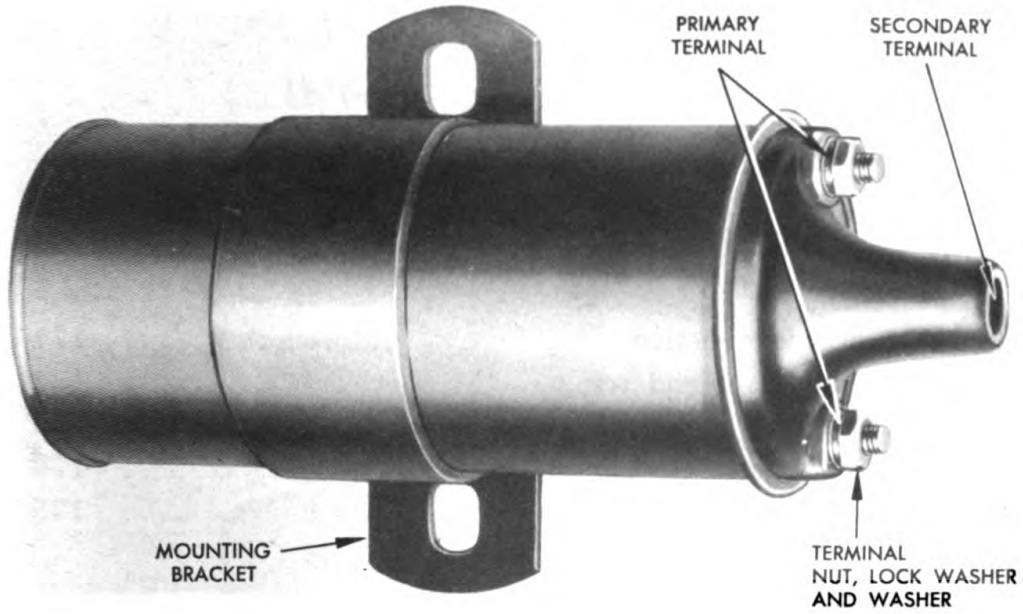
**ORDNANCE MAINTENANCE
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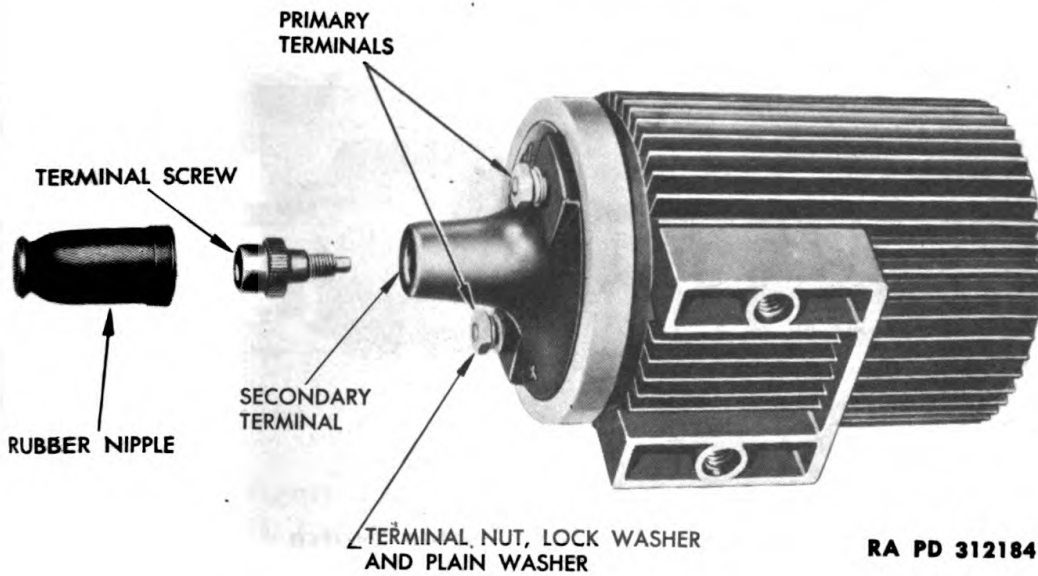
Figure 168—Sectional View of Oil-filled Ignition Coil

IGNITION COILS



RA PD 312183

Figure 169—Standard Type Ignition Coil



RA PD 312184

Figure 170—Heavy-duty Ignition Coil

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CHAPTER 6
MISCELLANEOUS (Cont'd)

Section II

GROUP I—SWITCHES

	Paragraph
Construction and function	171
Cleaning, inspection, and test.....	172
Disassembly	173
Cleaning, inspection, repair, and test of parts.....	174
Assembly	175

171. CONSTRUCTION AND FUNCTION.

a. This group of switches includes a wide variety of manually operated switches (figs. 171 through 188) which are designed to close and open electrical circuits to the various electrical devices in the electrical system. The switches illustrated are by no means all of

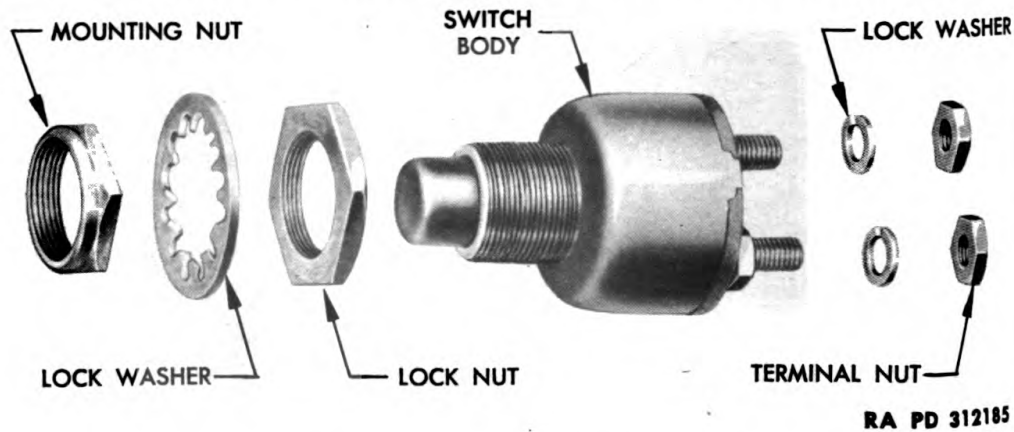


Figure 171—Push-button Switch

the switches used, but they are typical of the switches found on ordnance applications. On many switches, disassembly is confined to removing and replacing lead attaching nuts and lock washers and possibly operating knob, mounting nut, and lock washer. On others, the switch can be completely disassembled. Where disassembly and assembly is confined to removal and replacement of a few minor parts and is thus obvious, no further reference to the disassembly-assembly procedure is made. Where the disassembly-assembly procedure is less obvious, it is discussed in detail.

GROUP I—SWITCHES

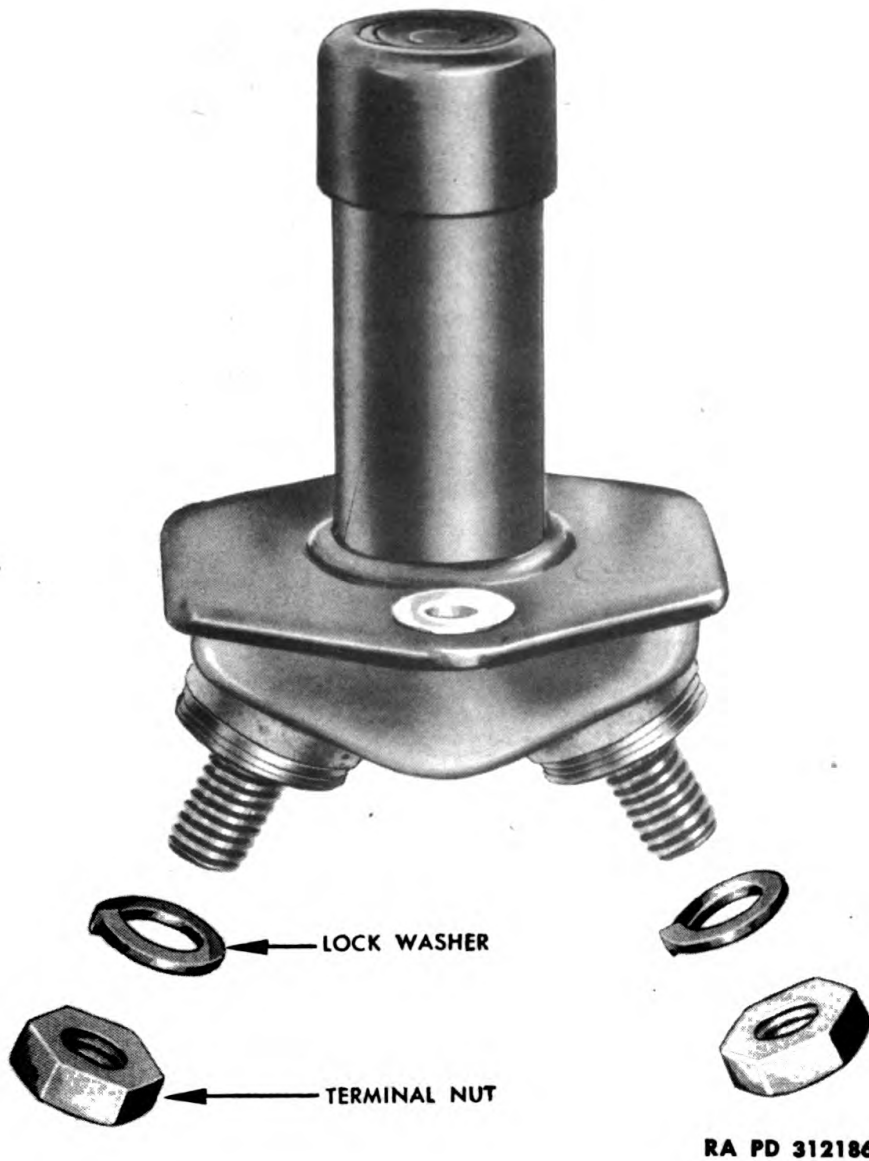


Figure 172—Cranking Motor Switch

172. CLEANING, INSPECTION, AND TEST.

a. Cleaning. Do not steam-clean or dip-clean switches since this will damage the contacts, insulators, and other parts. Clean by wiping with a clean cloth.

b. Inspection. Inspect switch action to make sure it is free and “snappy.” Check visible insulators for cracks or burned paths, and check screws for thread condition.

c. Test. Test manual switches for complete circuit when the switch is closed and open circuit with the switch open. Use a set of test points (fig. 12) connected to the switch terminals, operate the switch and note whether it opens and closes normally.

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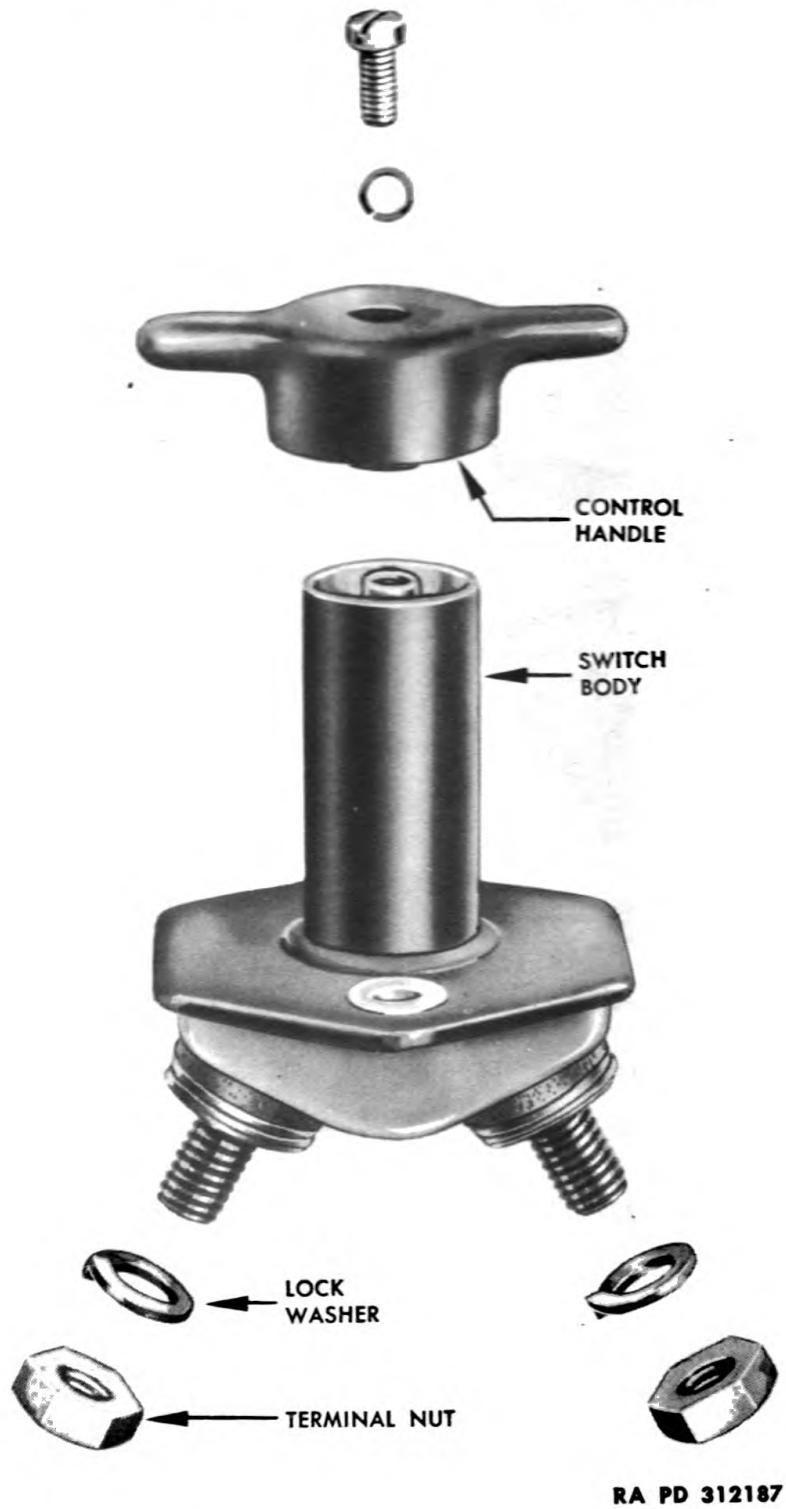
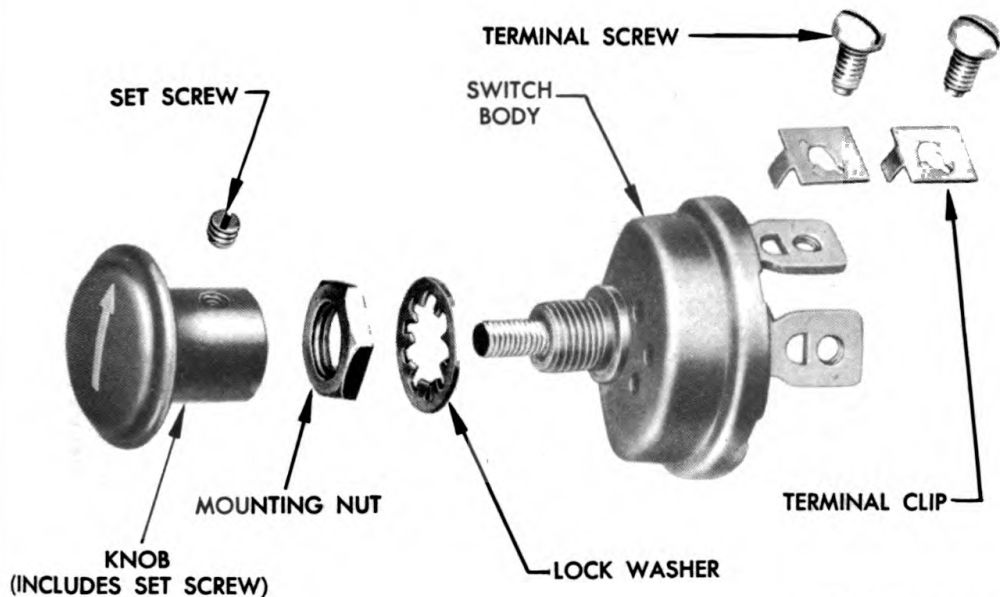


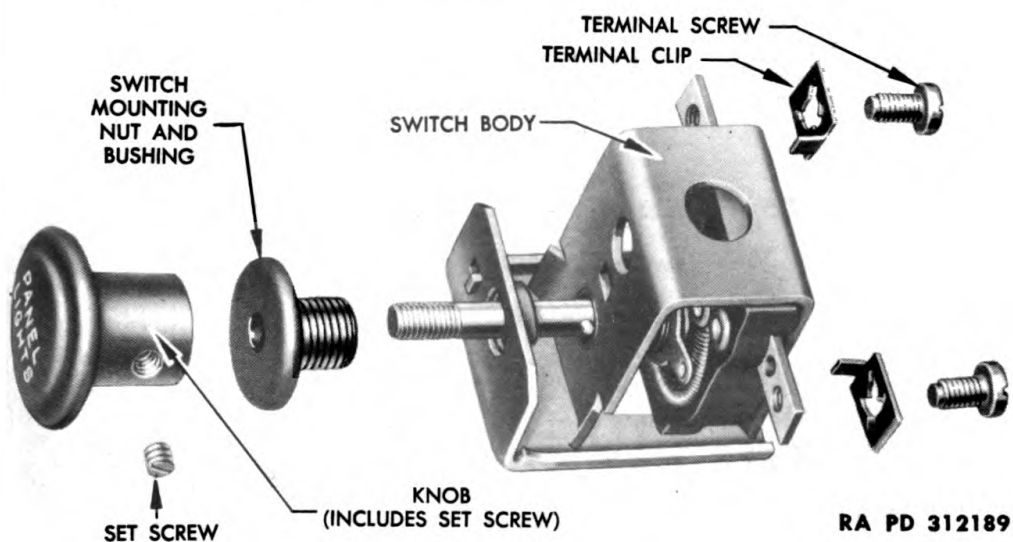
Figure 173—Master Switch

GROUP I—SWITCHES



RA PD 312188

Figure 174—Instrument Panel Switch



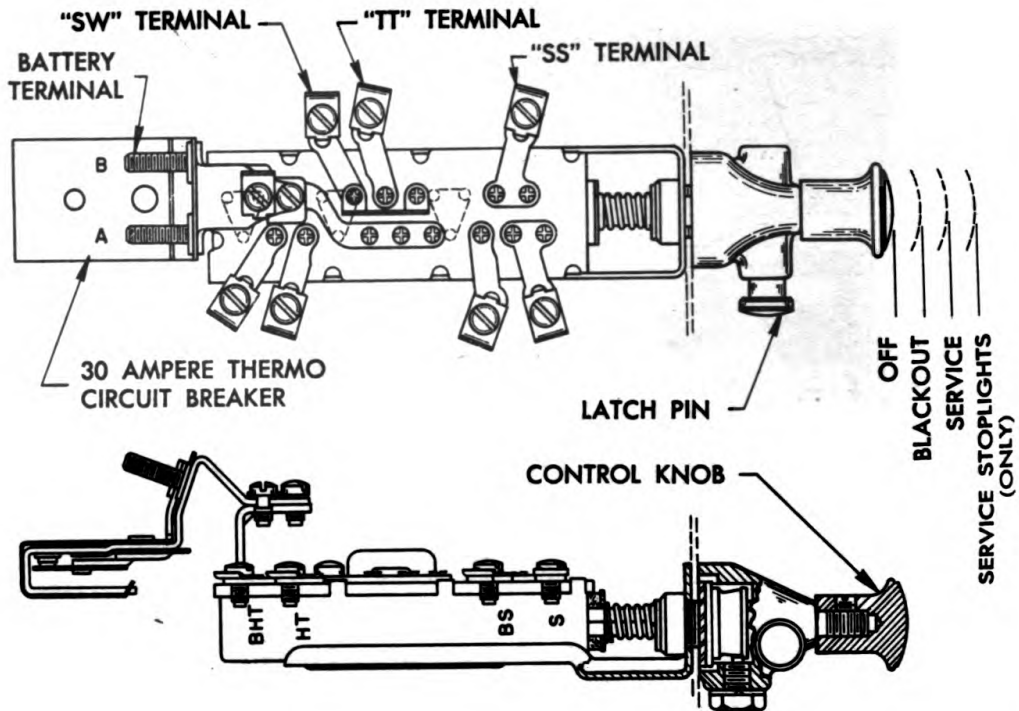
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Figure 175—Panel Light Switch

173. DISASSEMBLY.

a. **Ignition Switch** (fig. 179). Detach switch lever from remainder of assembly by inserting a stiff wire into the hole in the switch face with the switch in "ON" position and rotating the lever past "ON" position. The wire releases a small spring-loaded plunger which normally prevents movement of the lever past the "ON" position, and retains the switch lever in the switch.

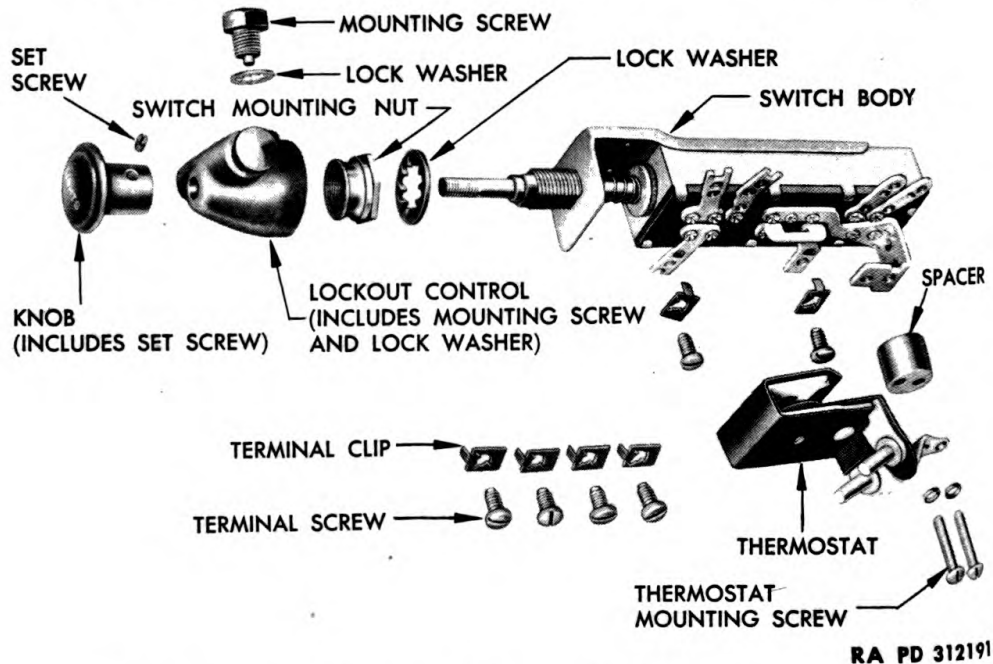
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NOTE: LATCH PIN MUST BE DEPRESSED BEFORE CONTROL KNOB CAN BE PULLED BEYOND BLACKOUT POSITION.

RA PD 312190

Figure 176—Sectional View of Blackout Lighting Switch



RA PD 312191

Figure 177—Blackout Lighting Switch, Disassembled

GROUP I—SWITCHES

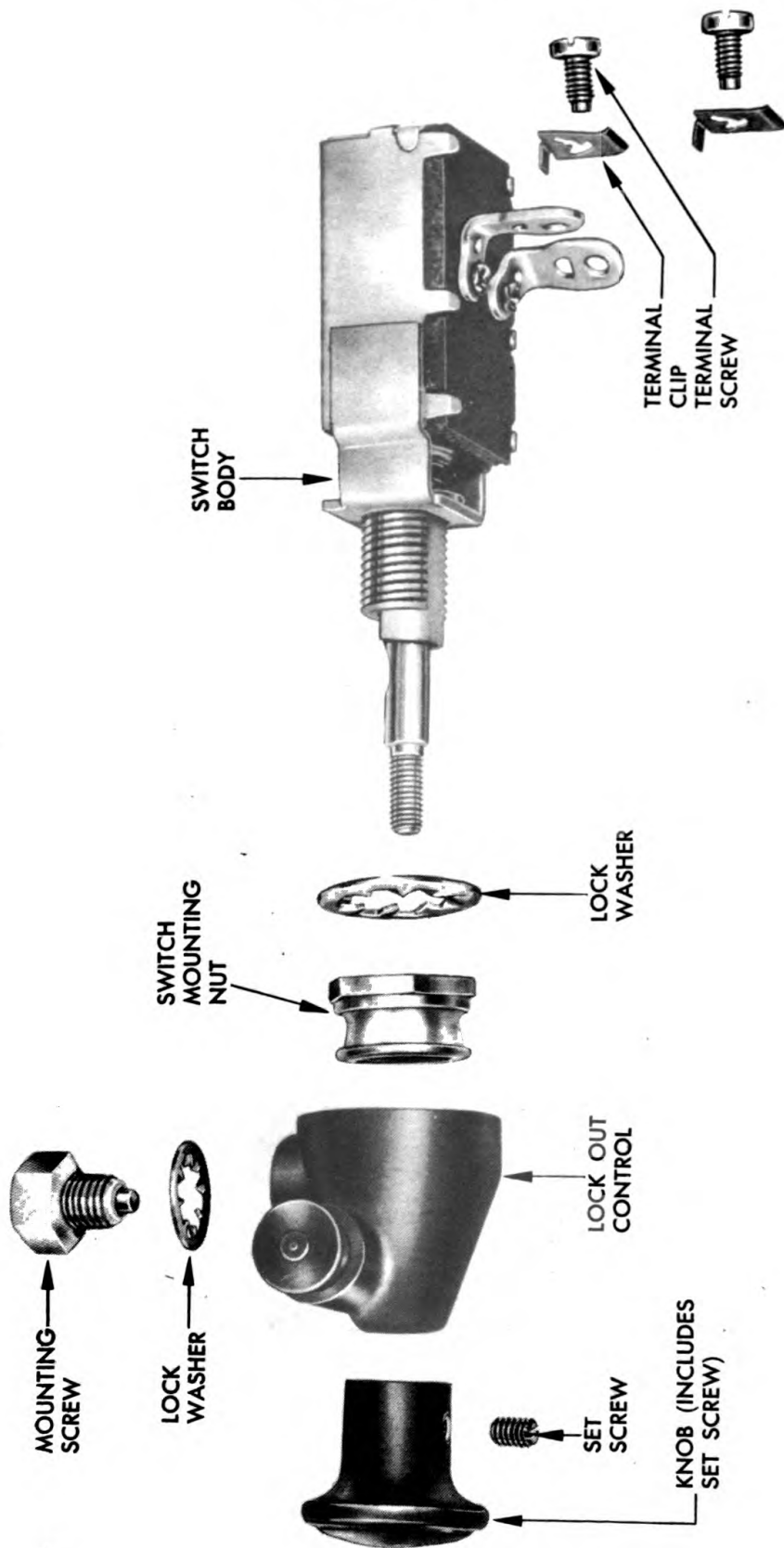


Figure 178—Blackout Driving Switch, Disassembled

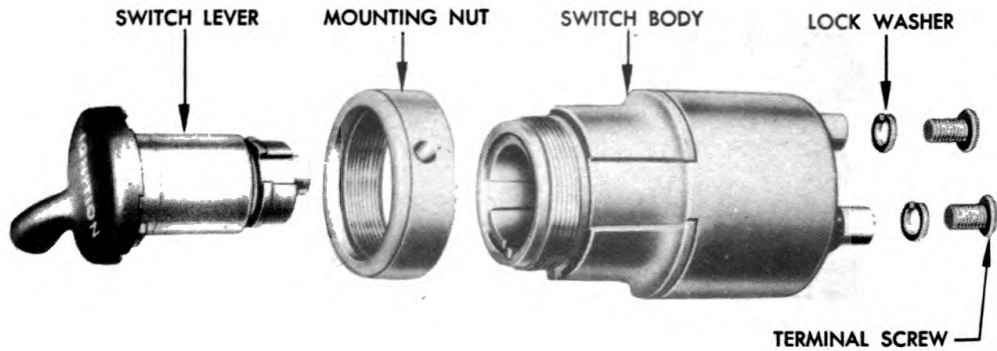
**ORDNANCE MAINTENANCE
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b. Sealed Ignition Switch (fig. 180).

- (1) Take off operating coupling by removing screw and lock washer. Remove seals from housing.
- (2) Take off mounting plate by removing three screws and lock washers.
- (3) Remove terminal plate by taking out six screws and lock washers.
- (4) Take off gasket, insulating plate, gasket, and take out contact plate, springs, rotor, and shaft.

c. Combination Switches (figs. 182 through 185). Combination switches vary in construction, but all are disassembled and assembled in practically the same manner.

- (1) Take off nuts and remove bracket.
- (2) Take off nuts and washers and remove shield.
- (3) Take off lead attaching screws and lock washers.
- (4) Take off two studs, three screws, and five lock washers and remove terminal plate.



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Figure 179—Ignition Switch

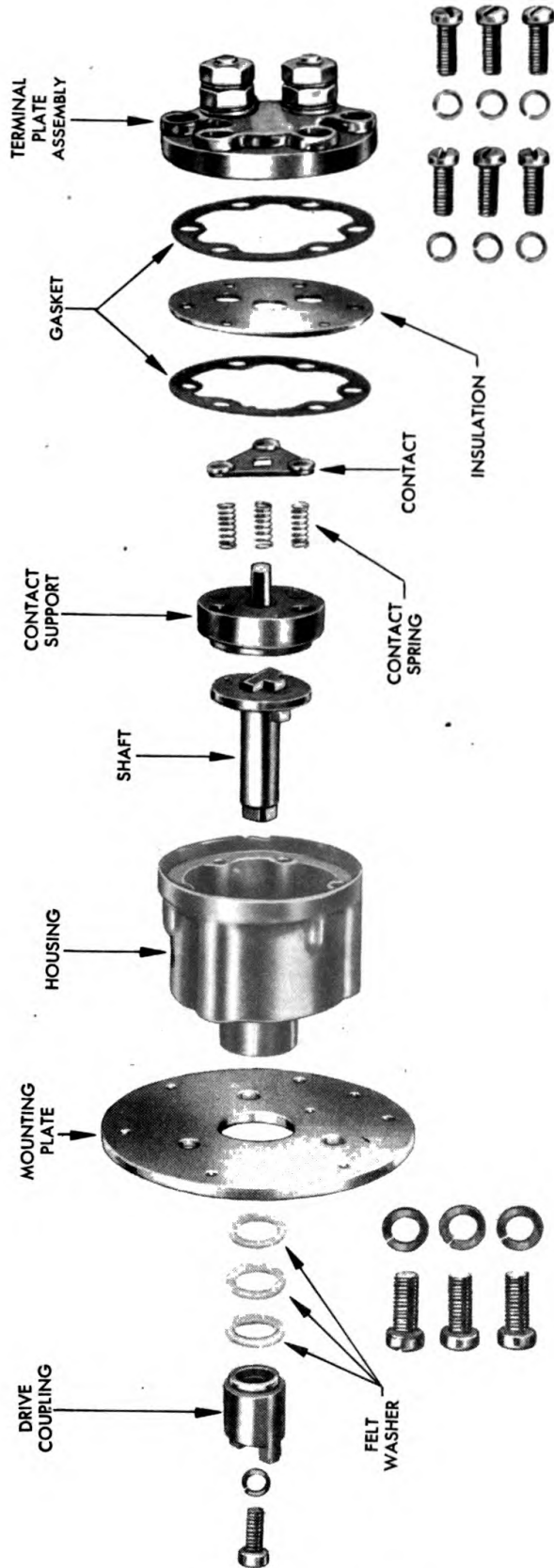
(5) Take out contact plates, springs, and rotors. Note positions of plates before removing them.

(6) Disassemble housing by removing lever attaching screws, lock washers, and levers. Take out seals. Remove rotors, springs, and ratchets.

d. Heavy-duty Cranking Motor Switch (figs. 186 through 188).

- (1) Remove four screws and lock washers and take off terminal plate and gasket. Pull cotter pin.
- (2) Take off push button assembly by unscrewing nut from housing.
- (3) Take off sleeve from housing shank.
- (4) Remove spiral spring, push out pins, and remove triggers.
- (5) Prevent push rod from turning with screwdriver and un-

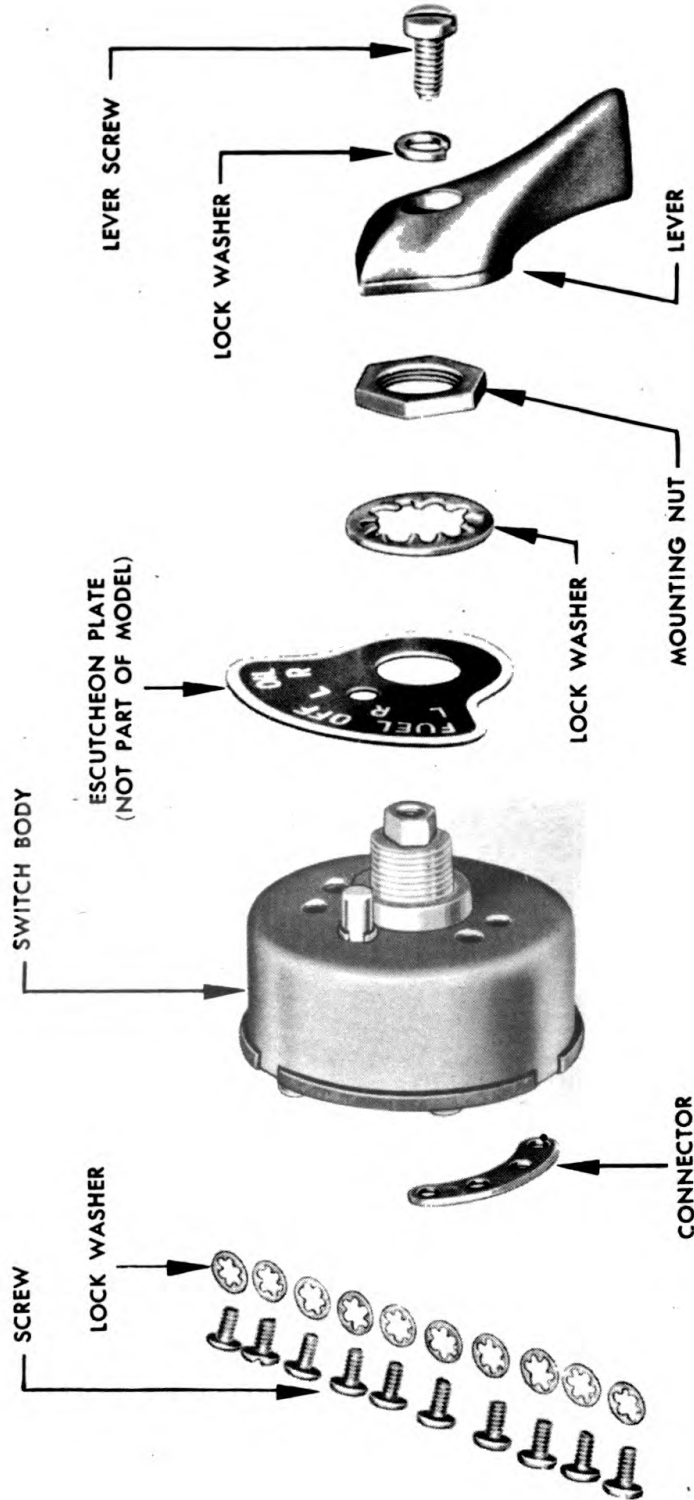
GROUP I—SWITCHES



RA PD 312194

Figure 180—Engine Compartment Mounted and Sealed Ignition Switch

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312195

Figure 181—Combination Fuel and Oil Indicator Switch

GROUP I—SWITCHES

RA PD 312196

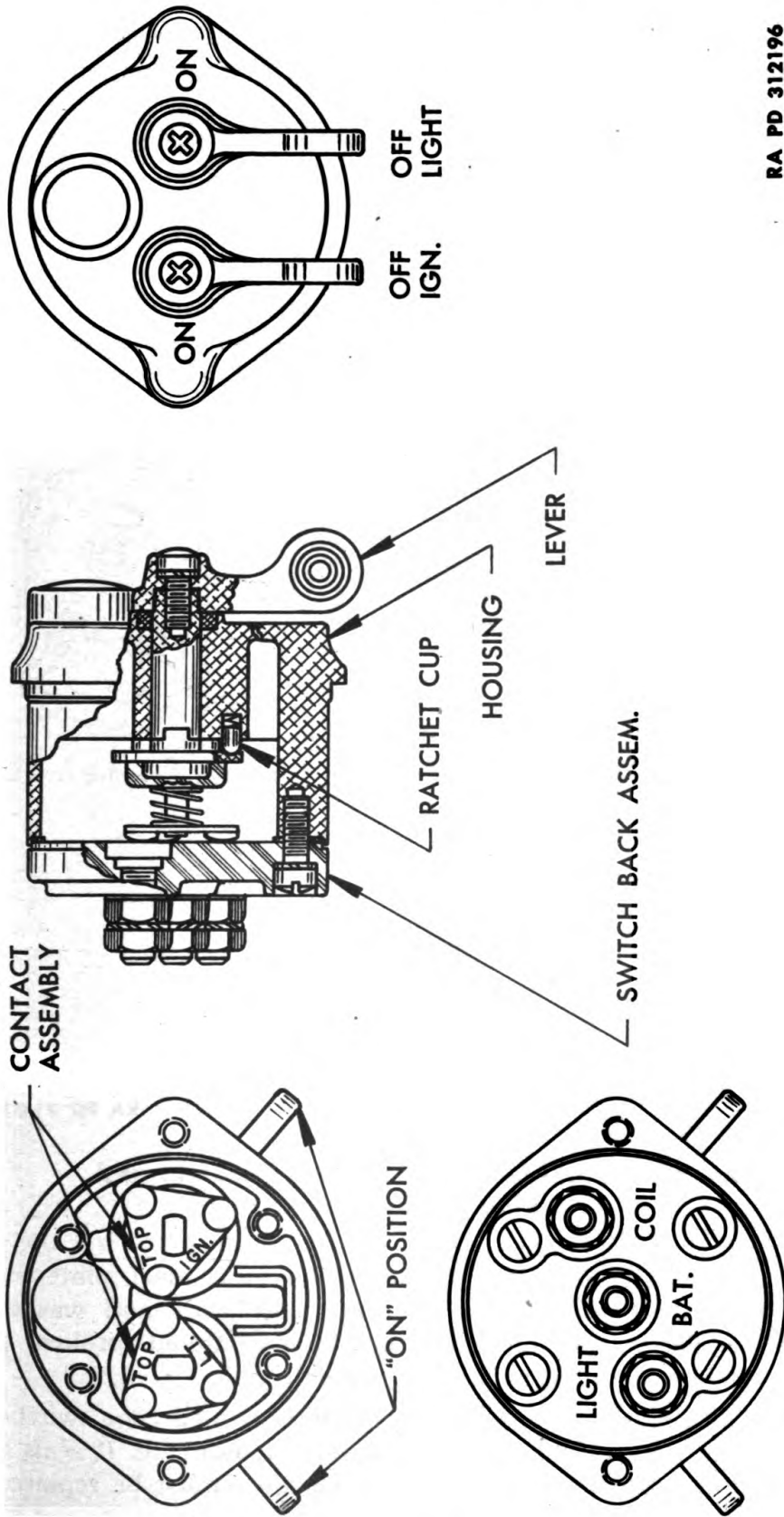


Figure 182—Combination Ignition and Lighting Switch

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**

screw castellated nut. Take out push rod and spring from one end, and contact disk, spring retainer, spring and spring retainer from other end of switch.

(6) Disassemble terminal plate by taking off nuts, lock washers, plain washers, insulators, and terminal screws.

**174. CLEANING, INSPECTION, REPAIR, AND TEST
OF PARTS.**

a. **General.** After disassembly, clean and examine all parts and replace defective parts. Do not clean insulators with solvents, since this weakens the insulation properties. Wipe with a clean cloth.

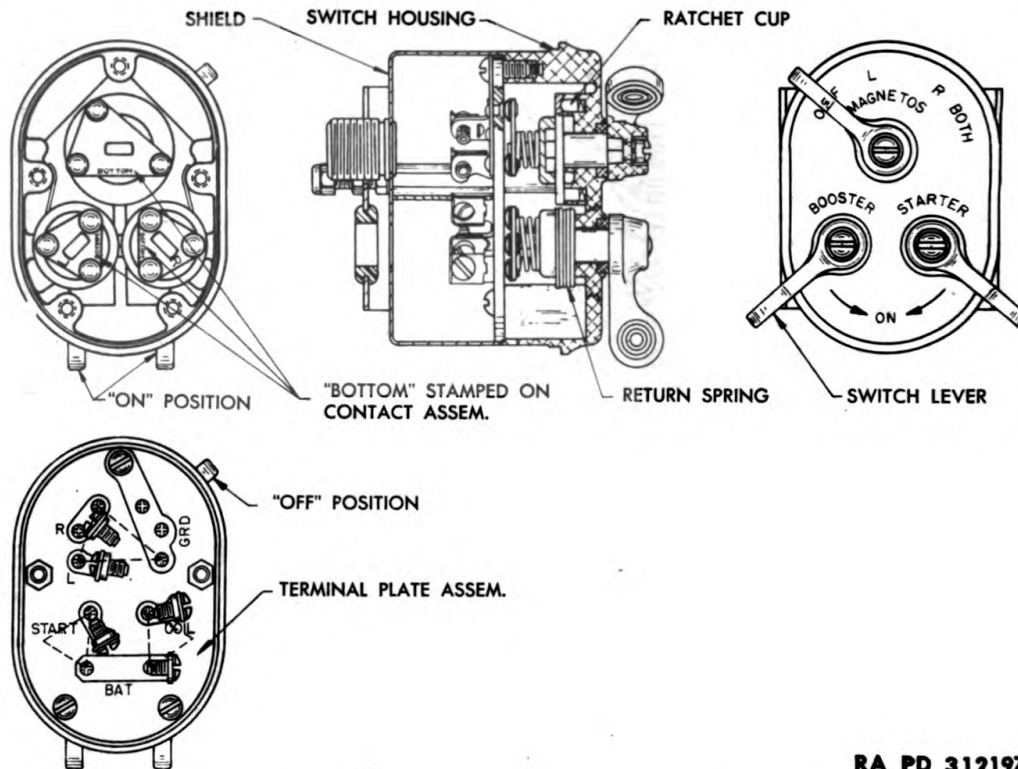


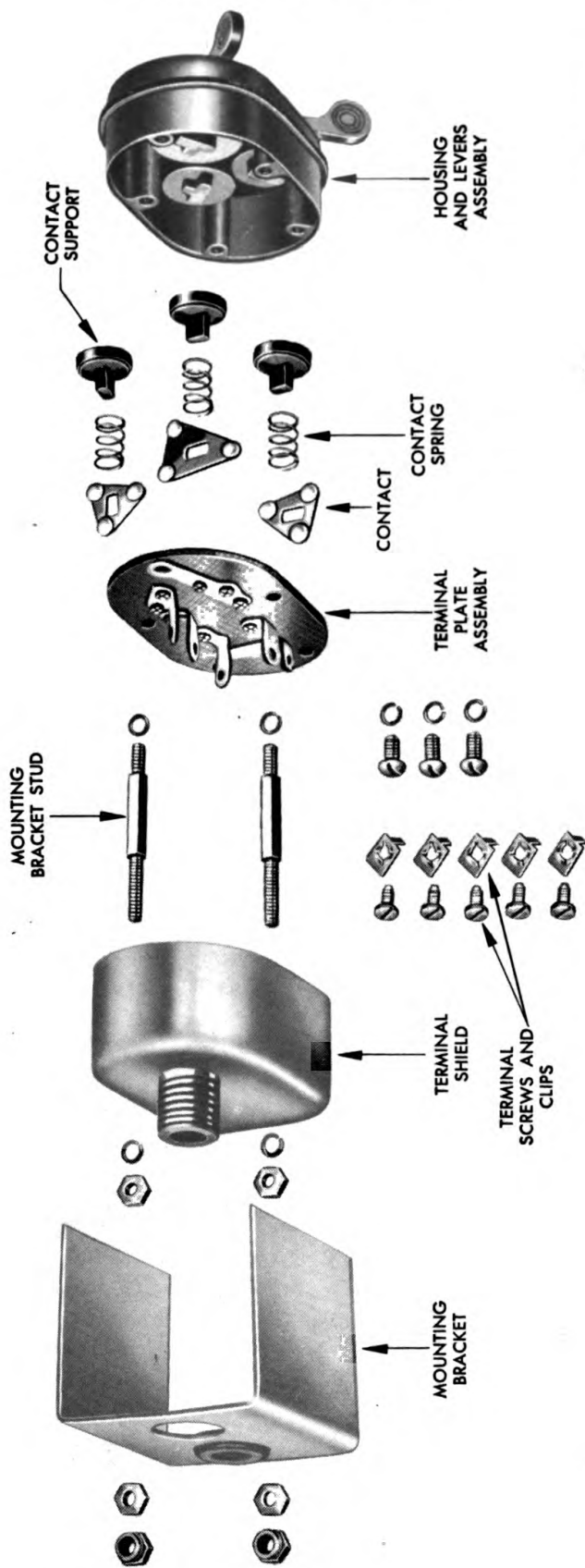
Figure 183—Combination Magneto, Booster, and Cranking Motor Switch

Replace any defective insulator, screw, washer, stud, seal, plate, etc. Cracked, bent, battered, worn, or burned insulators and washers are defective. Screws or studs that are bent, battered, broken, or that have crossed or damaged threads, are defective.

b. **Seals and Gaskets.** Seals and gaskets on sealed type switches are designed to prevent the entrance of dust or moisture. If seals or gaskets are hard, brittle, cracked or broken, they must be replaced.

c. **Contacts.** If contacts are burned away, they must be replaced.

GROUP I-SWITCHES



RA PD 312198

Figure 184—Disassembled View of Switch Shown in Figure 183

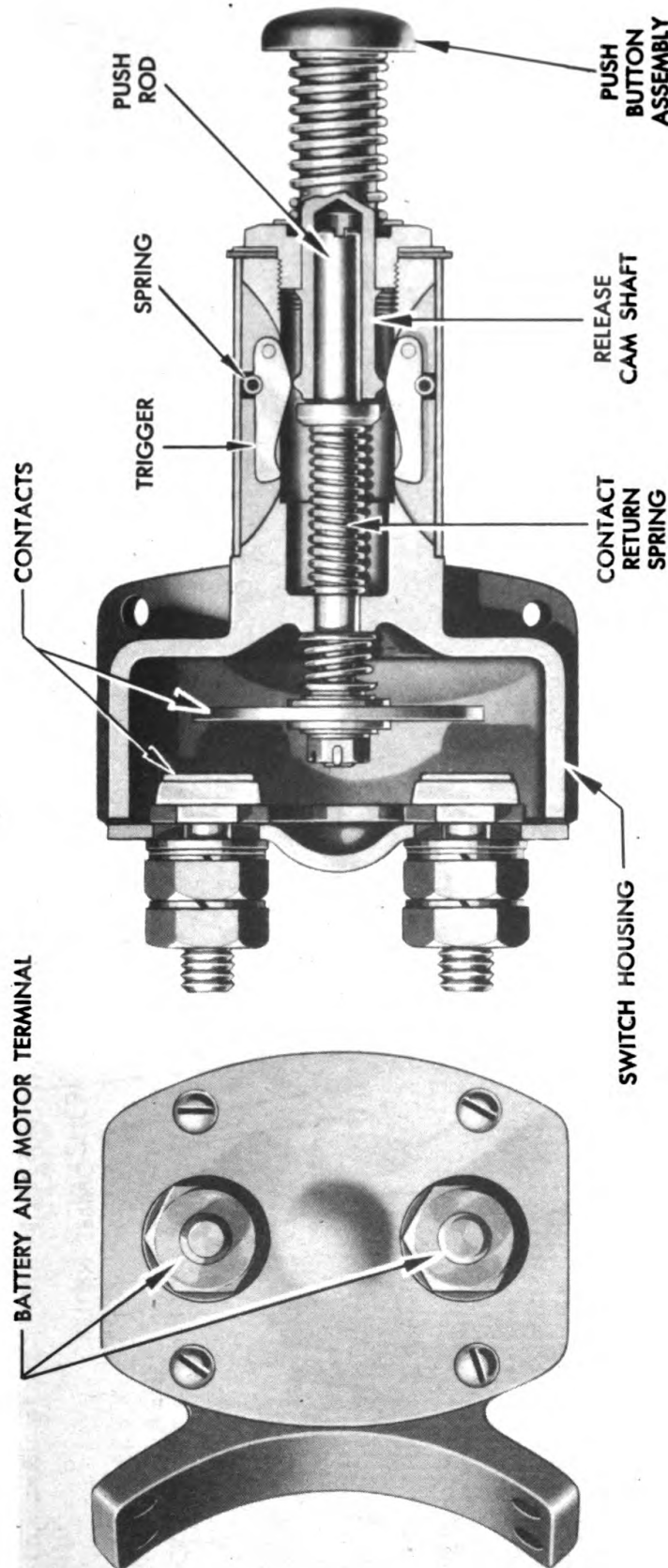
ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312199

Figure 185—Disassembled View of Housing of Switch Shown in Figure 183

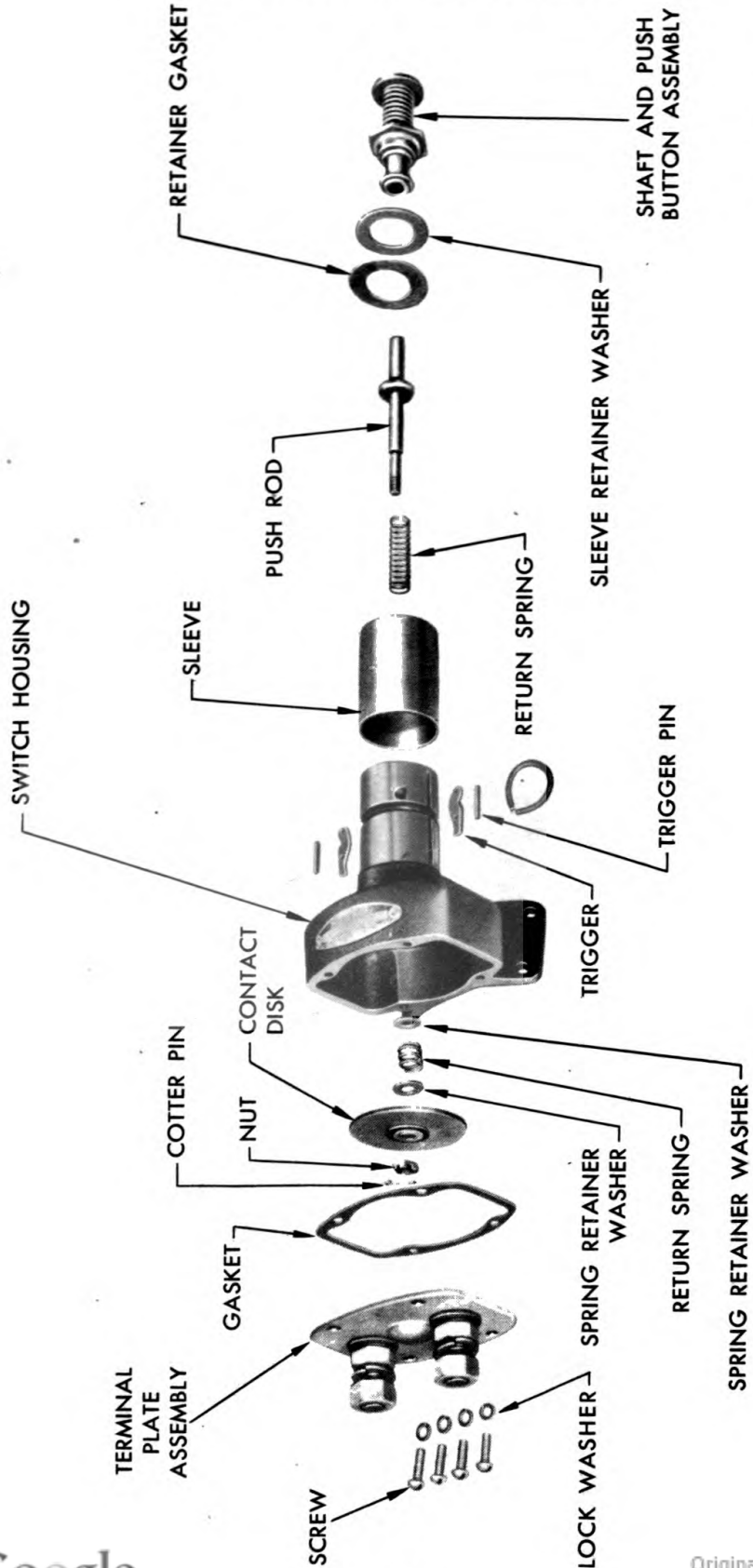
GROUP I-SWITCHES



RA PD 312200

Figure 186—Sectional View of Heavy-duty Cranking Motor Switch

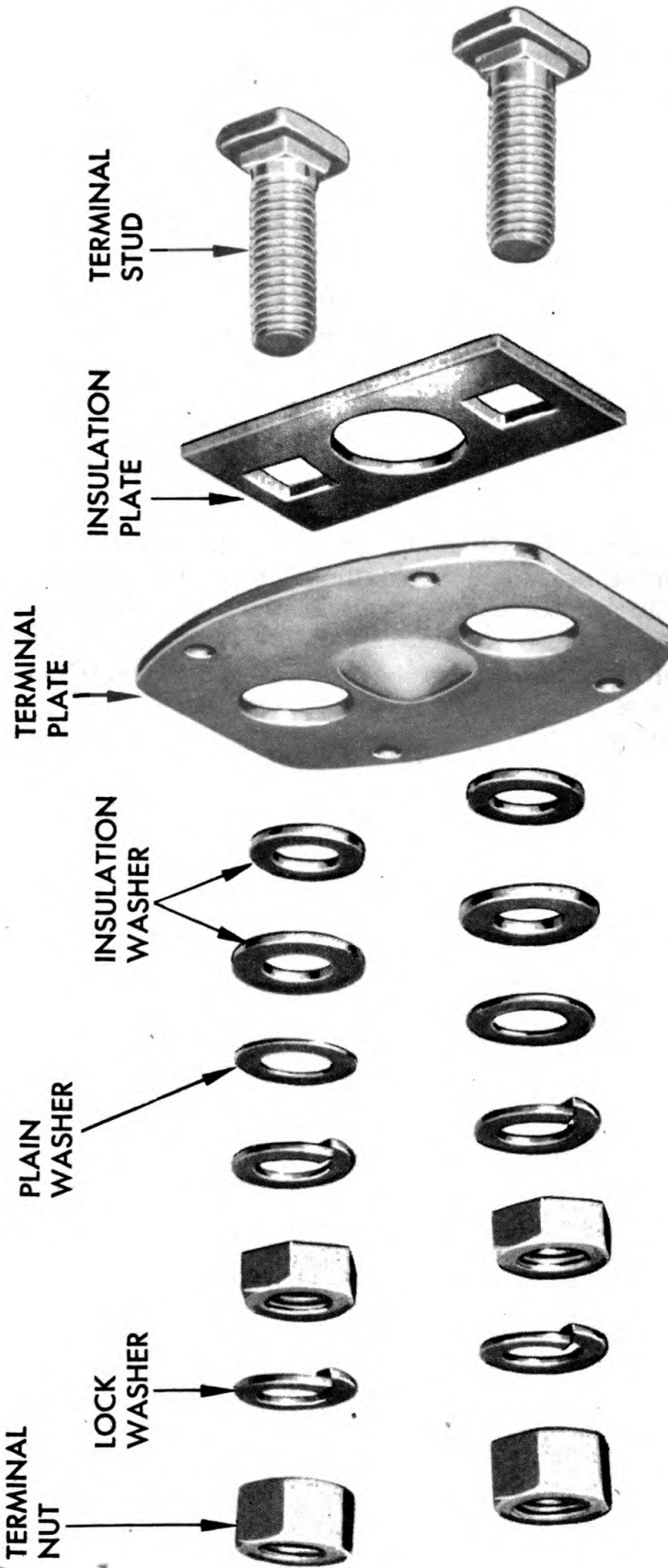
ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312201

Figure 187—Disassembled View of Switch Shown in Figure 186

GROUP I—SWITCHES



RA PD 312202

Figure 188—Disassembled View of Terminal Plate of Switch Shown in Figure 186

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

Heavy-duty type switches have large contacts that are cleaned by use of a file or wire brush. Use care to remove only sufficient material to clean off burned and blackened spots.

175. ASSEMBLY.

a. Ignition Switch (fig. 179). Assemble by placing switch lever into housing and rotating to the "ON" position.

b. Sealed Ignition Switch (fig. 180).

(1) Install shaft, rotor, springs and contact plate in position and secure with gasket, insulating plate, gasket, and terminal plate. Attach terminal plate with six screws and lock washers.

(2) Attach mounting plate with three screws and lock washers.

(3) Attach operating coupling with screw and lock washer after installing seals in housing.

c. Combination Switches (figs. 182 through 185).

(1) Assemble housing by installing levers with attaching screws and lock washers after putting seals in place. Install rotors, springs, and ratchets.

(2) Install contact plates, springs, and rotors. Note positions of plates in order to install them in correct locations.

(3) Attach terminal plate with two studs, three screws, and five lock washers.

(4) Put on lead attaching screws and lock washers.

(5) Attach shield with nuts and washers.

(6) Attach bracket with nuts.

d. Heavy-duty Cranking Motor Switch (figs. 186 through 189).

(1) Assemble terminal plate with terminal screws, insulators, washers, and nuts.

(2) Insert push rod with spring from one end and install on other end, spring retainer, spring, spring retainer, and contact disk. Secure with castellated nut. Turn nut down until face of contact disk is 0.310 to 0.325 inch below end of push rod.

(3) Install triggers with pins and put spiral spring and sleeve in place. Seal around lower edge of sleeve with Permatex No. 1.

(4) Adjust contact disk position by turning castellated nut so that face of disk is $\frac{9}{32}$ inch below edge of housing with push rod held in forward position by triggers. Secure nut with cotter pin. Bend pin so it will not interfere with switch action.

(5) Place small amount of medium grease in push button end of switch, coating triggers and push rod. Avoid excessive grease.

(6) Put gasket on end of housing, install washer and push button assembly.

(7) Attach terminal plate assembly with four screws and lock washers with gasket in place.

CHAPTER 6
MISCELLANEOUS (Cont'd)

Section III

GROUP II—SWITCHES

	Paragraph
Construction and function	176
Cleaning, inspection, and test.....	177
Disassembly of manually operated series-parallel switch...	178
Disassembly of solenoid operated series-parallel switch....	179
Cleaning, inspection, repair, and test of parts.....	180
Assembly of manually operated series-parallel switch.....	181
Assembly of solenoid operated series-parallel switch.....	182

176. CONSTRUCTION AND FUNCTION.

a. This group of switches includes manually and solenoid operated series-parallel switches. These switches are for use with cranking motors and two batteries. The batteries are connected in parallel through the series-parallel switch for normal running of the vehicle, but are connected in series through the series-parallel switch when the switch is operated for starting so that double the normal voltage is available to the cranking motor. This doubled voltage provides adequate cranking power for starting under adverse conditions. Figure 189 illustrates a phantom view of a manually operated series-parallel switch while figure 190 shows a schematic diagram of a series-parallel switch circuit.

177. CLEANING, INSPECTION, AND TEST.

a. **Cleaning.** Do not steam-clean or dip-clean switch since this will injure the contacts, insulators, or other parts and, on the solenoid operated switch, would damage the solenoid winding.

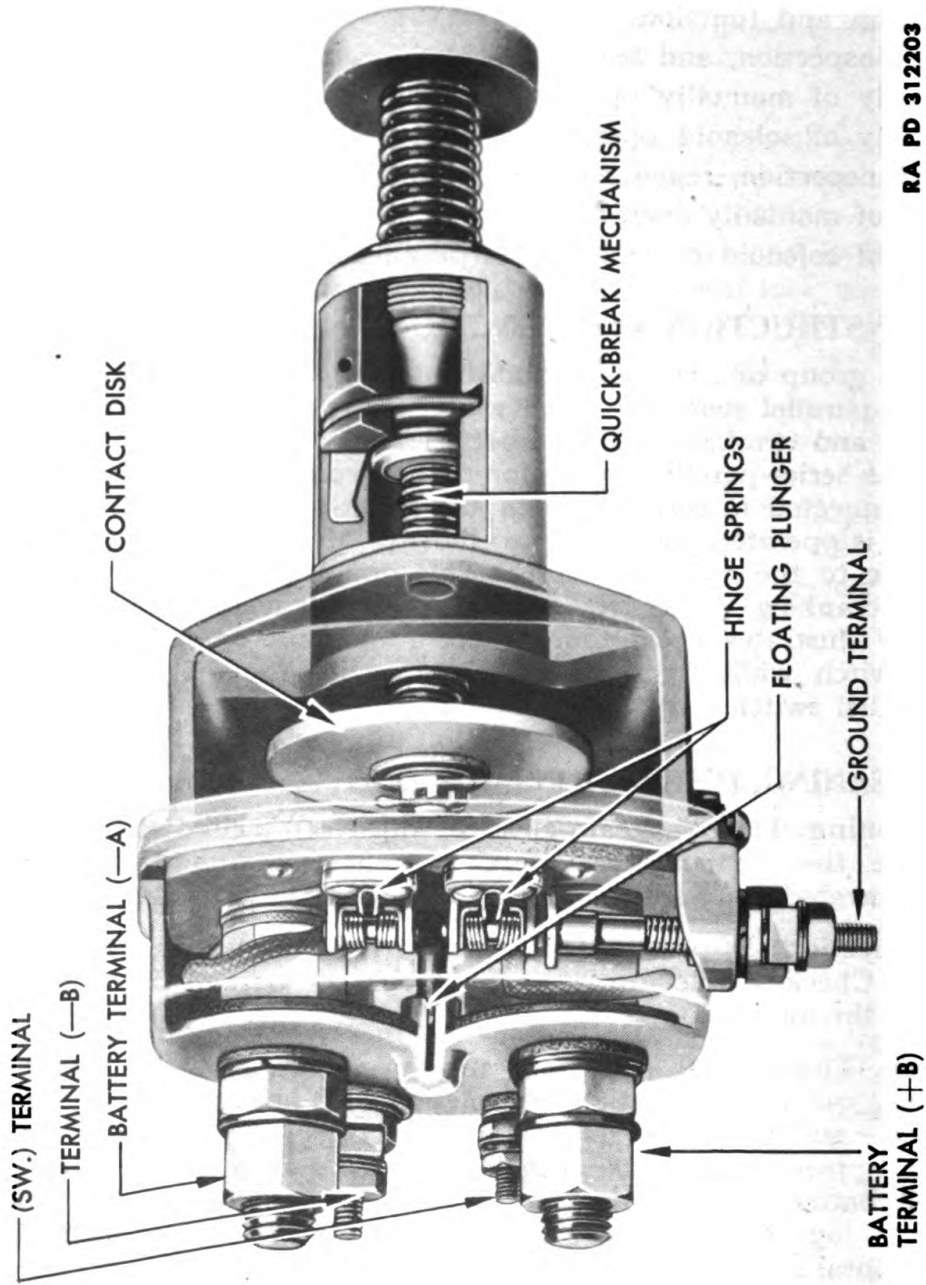
b. **Inspection.** Inspect switch action to make sure it is free and "snappy." Check visible insulators for cracks or burned paths and screws for thread condition.

c. **Test.** The manual switch is tested by operating switch button and noting quick-break action, completion and opening of circuits through the switch. Use a set of test points (fig. 12) to check for closed and open circuit. The solenoid operated switch is tested with a 12-volt battery connected in series with a variable resistance so variable voltage can be applied to the solenoid. With the solenoid in a horizontal position, it must operate at 8-9 volts.

178. DISASSEMBLY OF MANUALLY OPERATED SERIES-PARALLEL SWITCH (figs. 191 through 193).

a. From -A and +B terminals remove nuts, lock washers, plain washers, insulating washers, and insulating washer bushings.

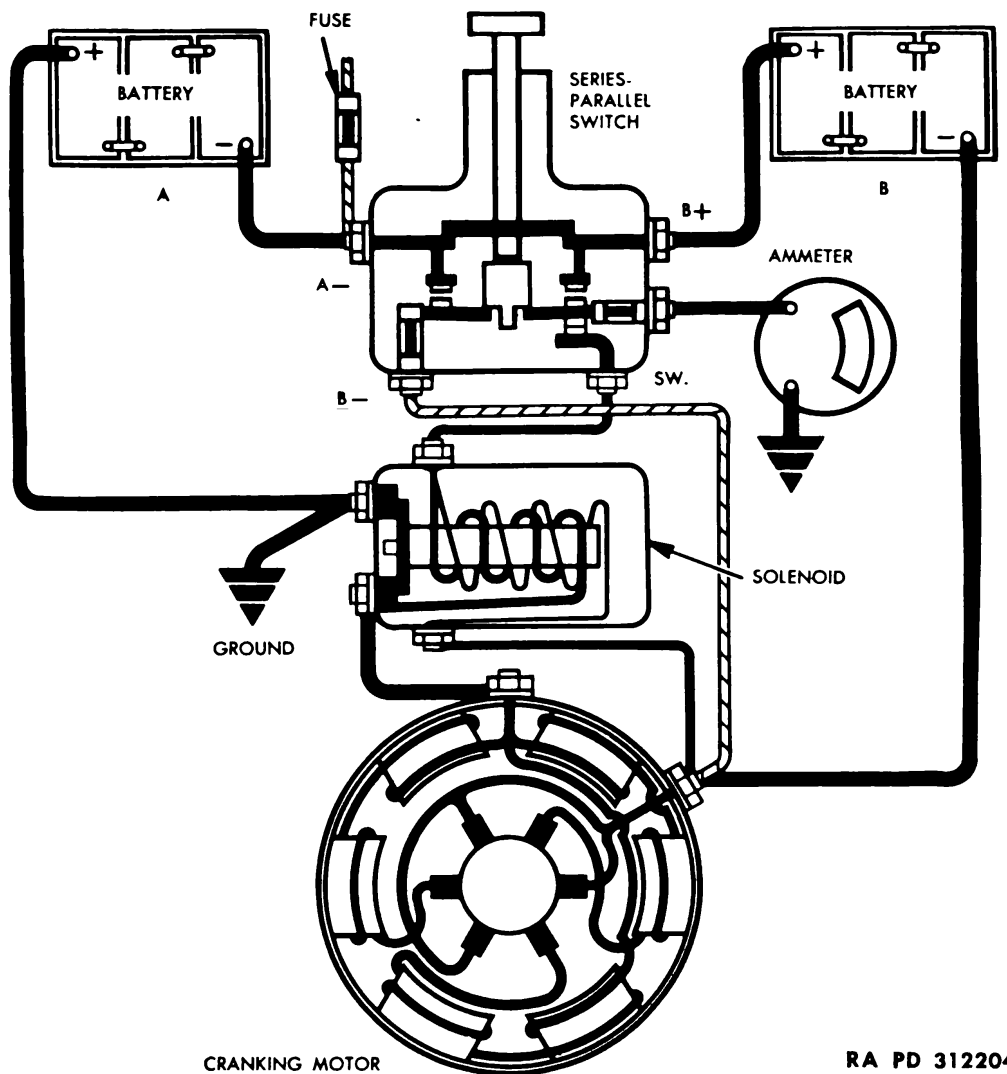
ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312203

Figure 189—Phantom View of Manually Operated Series-parallel Switch

GROUP II—SWITCHES



CRANKING MOTOR

RA PD 312204

Figure 190—Series-parallel Switch Circuit with Switch in the Cranking Position and Series Connections Completed

b. From $-B$ and ground terminals (fig. 189), remove nuts, lock washers, plain washers, terminal assemblies, lock washers, and plain washers.

c. From SW terminal (fig. 189), remove nut, lock washer, washer, nut, lock washer, washer, and insulating bushing.

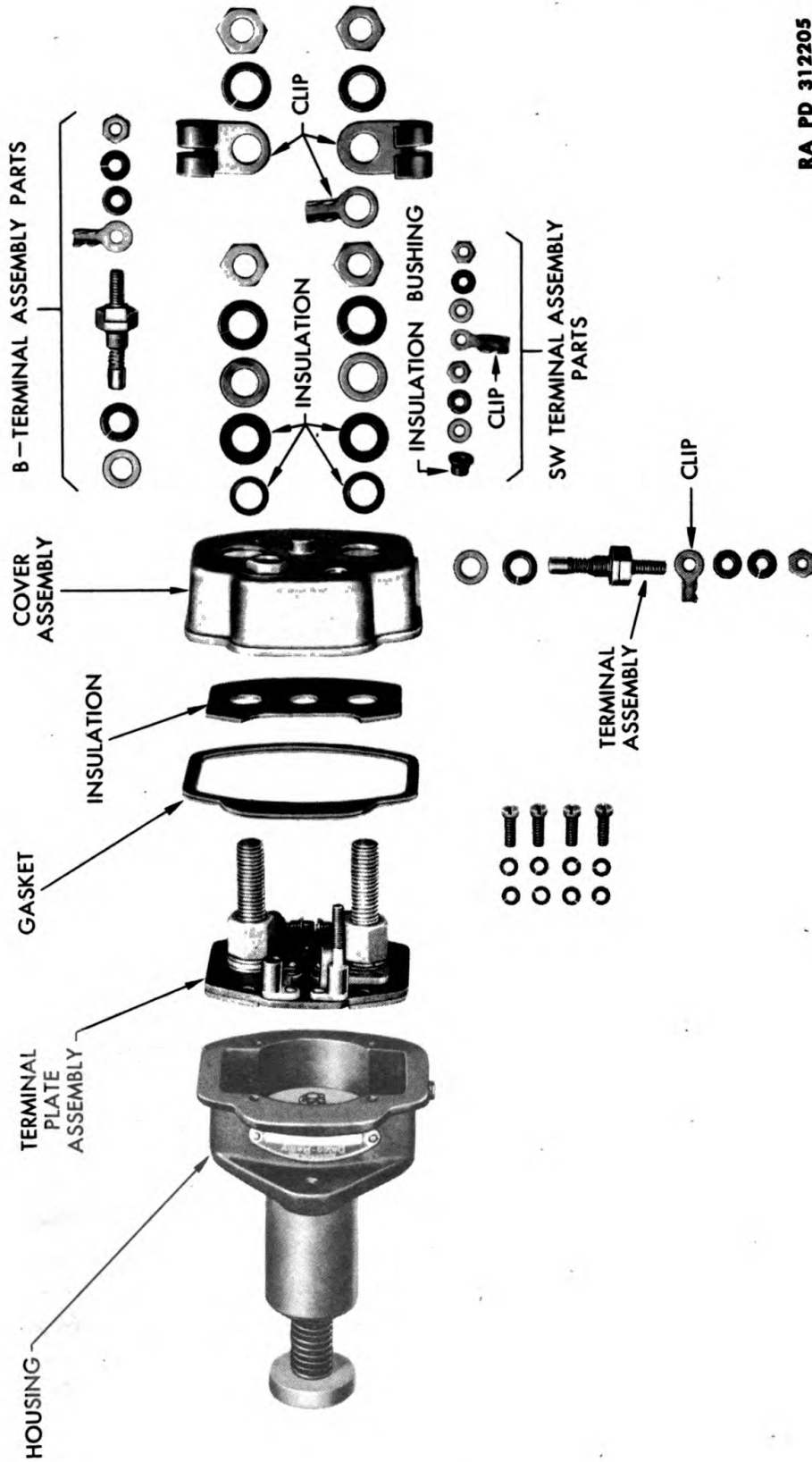
d. Lift off cover, cover gasket, and insulating plate.

e. Detach terminal assembly from switch housing by removing four screws, lock washers, and washers.

f. Disassemble terminal assembly.

(1) Remove nuts, lock washers, washers, and terminal studs, along with insulating plates.

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ELECTRICAL EQUIPMENT (DELCO-REMY)



RA PD 312205

Figure 191—Manually Operated Series-parallel Switch, Disassembled

RA PD 312206

GROUP II—SWITCHES

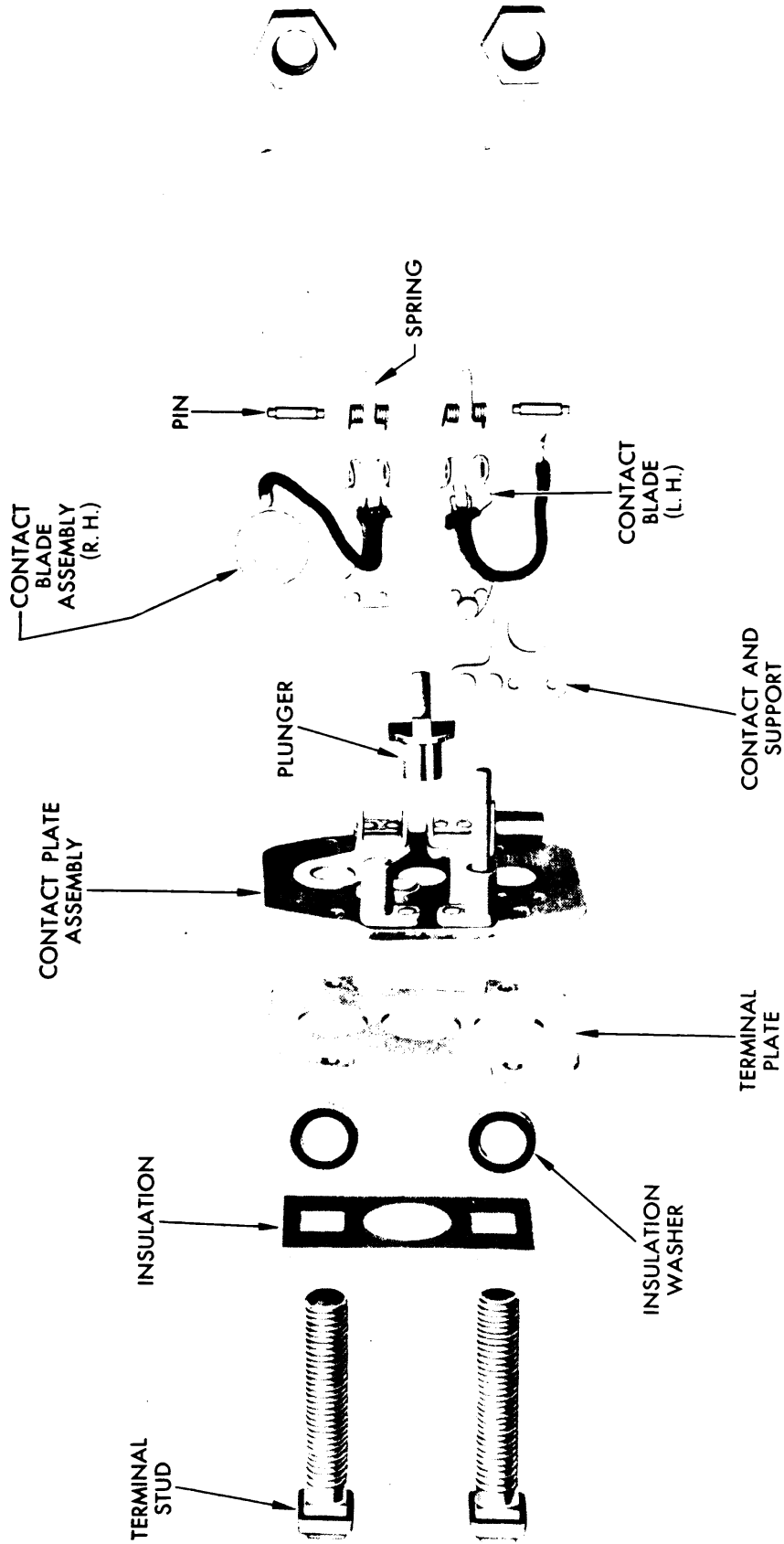
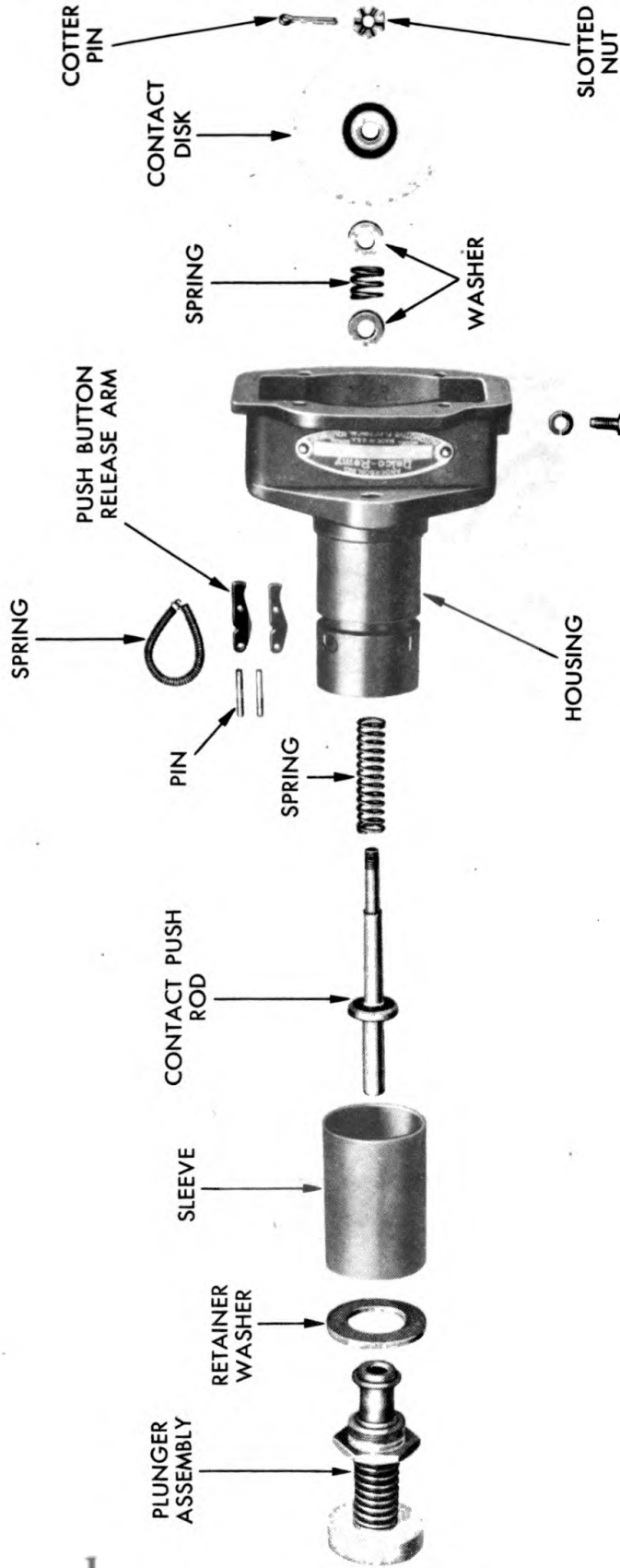


Figure 192—Terminal Assembly, Disassembled

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ELECTRICAL EQUIPMENT (DELCO-REMY)**



RA PD 312207

Figure 193—Switch Housing, Disassembled

GROUP II—SWITCHES

RA PD 312208

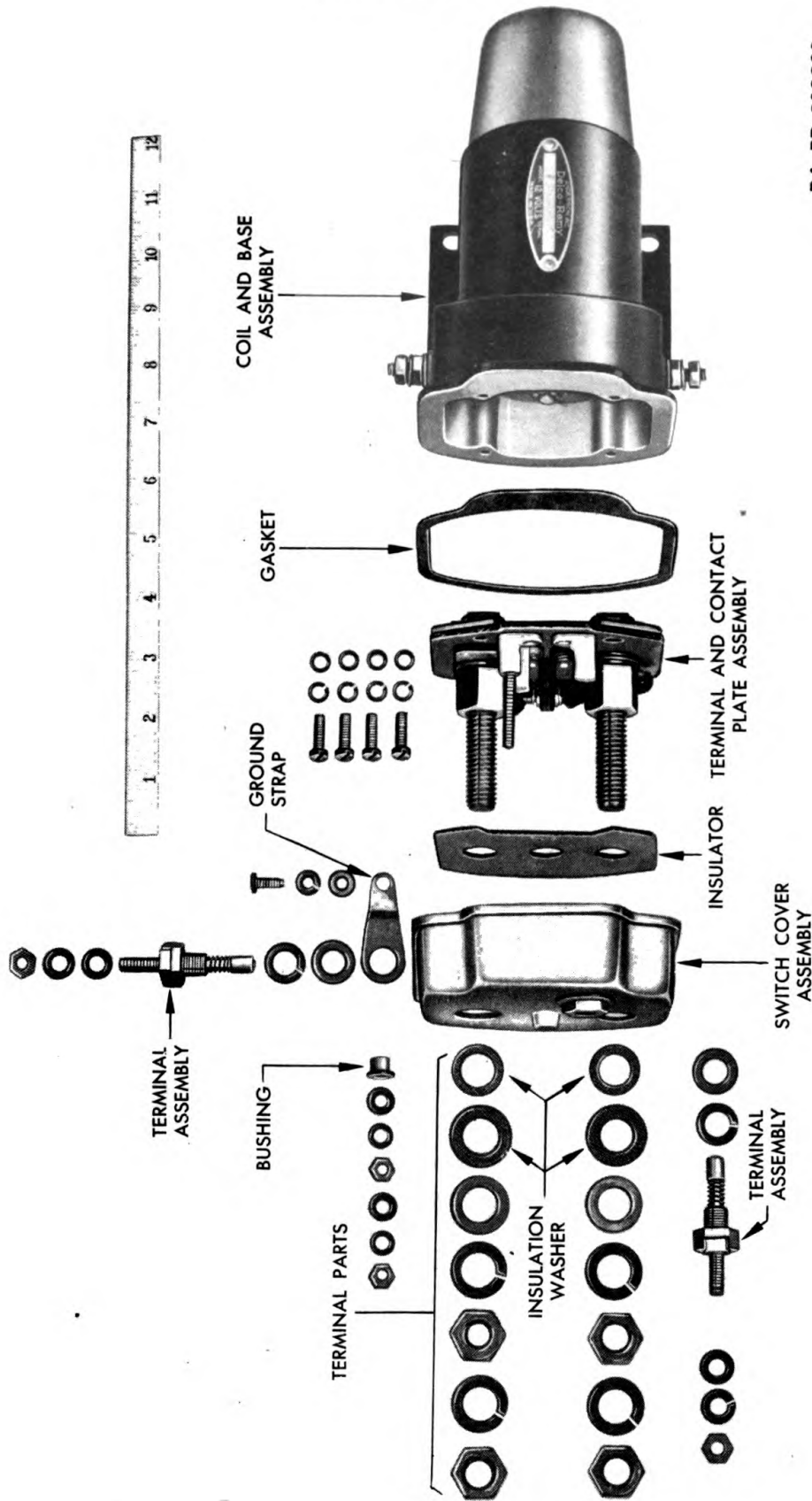
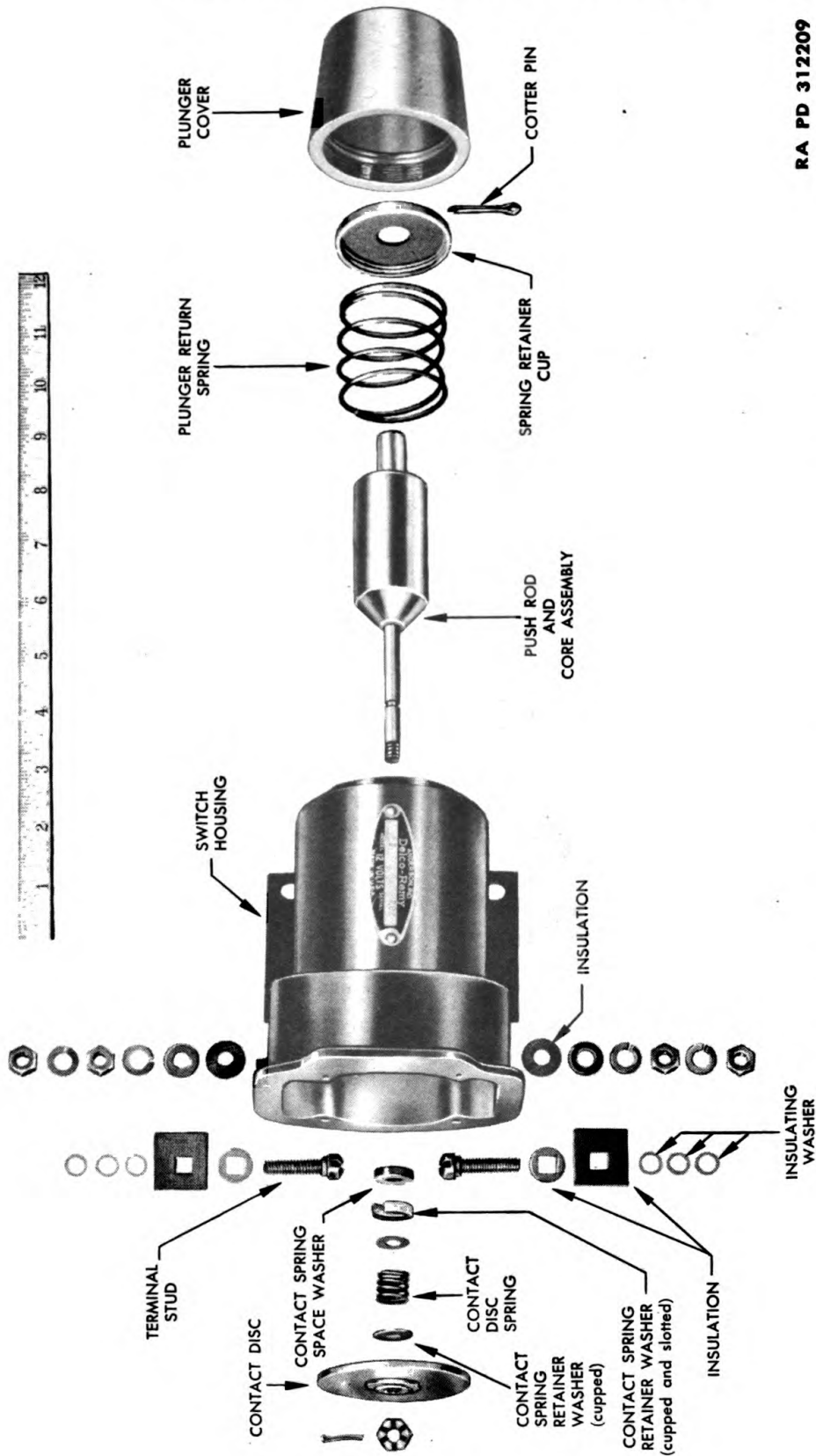


Figure 194—Solenoid-operated Series-parallel Switch, Disassembled

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ELECTRICAL EQUIPMENT (DELCO-REMY)**



RA PD 312209

Figure 195—Solenoid and Terminals, Disassembled

GROUP II—SWITCHES

(2) Remove pins, springs, and contact blades, and take off plunger and contact support.

g. Disassemble housing (par. 173 d).

179. DISASSEMBLY OF SOLENOID OPERATED SERIES-PARALLEL SWITCH (figs. 194 and 195).

a. Take off end cover, and disassemble terminal assembly (par. 178 a through f).

b. Disassemble solenoid and terminals.

(1) Take off movable core cover by clamping it lightly in soft jaws of vise and turning it off.

(2) Take out cotter pin, spring retainer, and spring from movable core end.

(3) Take out cotter pin, nut, disk, spring retainer, spring, washer, U-shaped spring retainer, washer (from opposite end), movable core, and rod.

(4) Disassemble terminals by unsoldering leads, removing nuts, lock washers, plain washers, insulating washers, three bushing washers, and terminal screws. Take insulating plate and plain washer off square shoulder of screw. *NOTE: An earlier type construction made use of eye clips, soldered to the solenoid leads and fastened under the terminal screw heads. On this type construction, the terminal screws had no square shoulders and there was a tendency for the screws and clips to turn if the nuts were carelessly tightened. New screws, square hole plain washers, and insulators will change over the unit to the new type construction. Unsolder clips from leads and solder leads in screw head slots after assembly of terminal screws has been completed.*

180. CLEANING, INSPECTION, REPAIR, AND TEST OF PARTS.

a. Refer to paragraph 174.

181. ASSEMBLY OF MANUALLY OPERATED SERIES-PARALLEL SWITCH (figs. 191 through 193).

a. Assemble Terminal Assembly.

(1) Put plunger and contact support in position, attach contact blades and springs with pins.

(2) Attach terminal studs and insulating plates with washers, nuts, and lock washers.

b. Assemble housing (par. 175 d).

c. Attach terminal assembly to switch housing with four screws, lock washers, and washers.

d. Put cover, cover gasket, and insulating plate, in place and secure with insulating washer bushings, insulating washers, plain washers, lock washers, and nuts on the -A and +B terminals.

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

- e. Install —B and ground terminals with lock washers and plain washers and add plain washers, lock washers, and nuts.
- f. Install insulating bushing, lock washers, nuts, and washers on SW terminal.

182. ASSEMBLY OF SOLENOID OPERATED SERIES-
PARALLEL SWITCH (figs. 194 and 195).

- a. Assemble terminals to switch housing by placing square hole washers and insulating plates on square shoulders of screws. Insert screws through holes and secure with bushing washers, insulating washers, plain washers, lock washers, and nuts. Edge of insulating plate must lay against back of housing to prevent screw from turning. Solder solenoid leads into screw head slots. See paragraph 179 b (4), concerning changing over the older type construction.
- b. Install movable core and rod and place on rod, the washer, U-shaped spring, retainer, washer, spring, spring retainer, disk, nut, and cotter pin. Turn nut on rod until face of disk is $2\frac{5}{32}$ inch below edge of housing with rod in the retracted position. Bend cotter pin out of way so it does not interfere with switch action.
- c. Attach spring and spring retainer with cotter pin and replace movable core cover.
- d. Assemble terminal assembly, install with end cover (par. 181 a, c, d, e, and f).

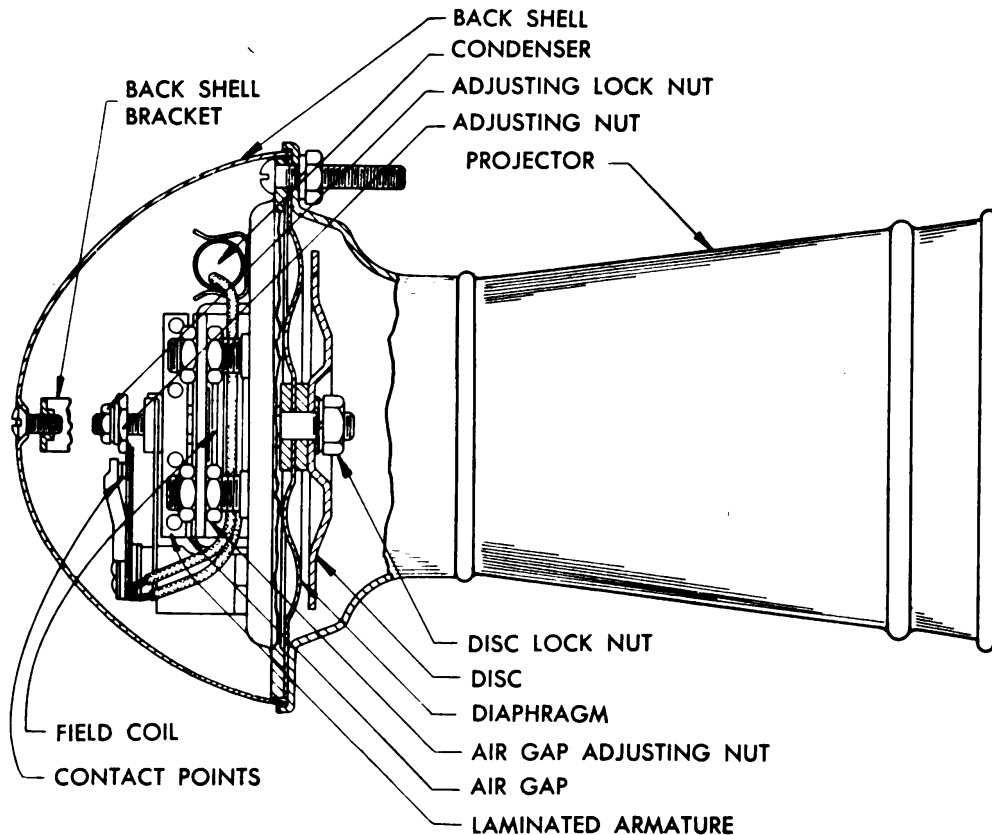
CHAPTER 6
MISCELLANEOUS (Cont'd)

Section IV
HORNS

	Paragraph
Construction and function	183
Cleaning, inspection, and test	184
Disassembly	185
Cleaning, inspection, repair, and test of parts	186
Assembly	187
Adjusting horn	188

183. CONSTRUCTION AND FUNCTION.

a. Horns are designed to produce a warning signal when the circuit between them and the battery is closed by a switch. The horn consists of an armature attached to a metal diaphragm and a winding that magnetically attracts the armature when the winding is connected to the battery. As the armature moves toward the winding, it causes a pair of contact points to open so that the winding loses



RA PD 312210

Figure 196—Sectional View of Horn

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

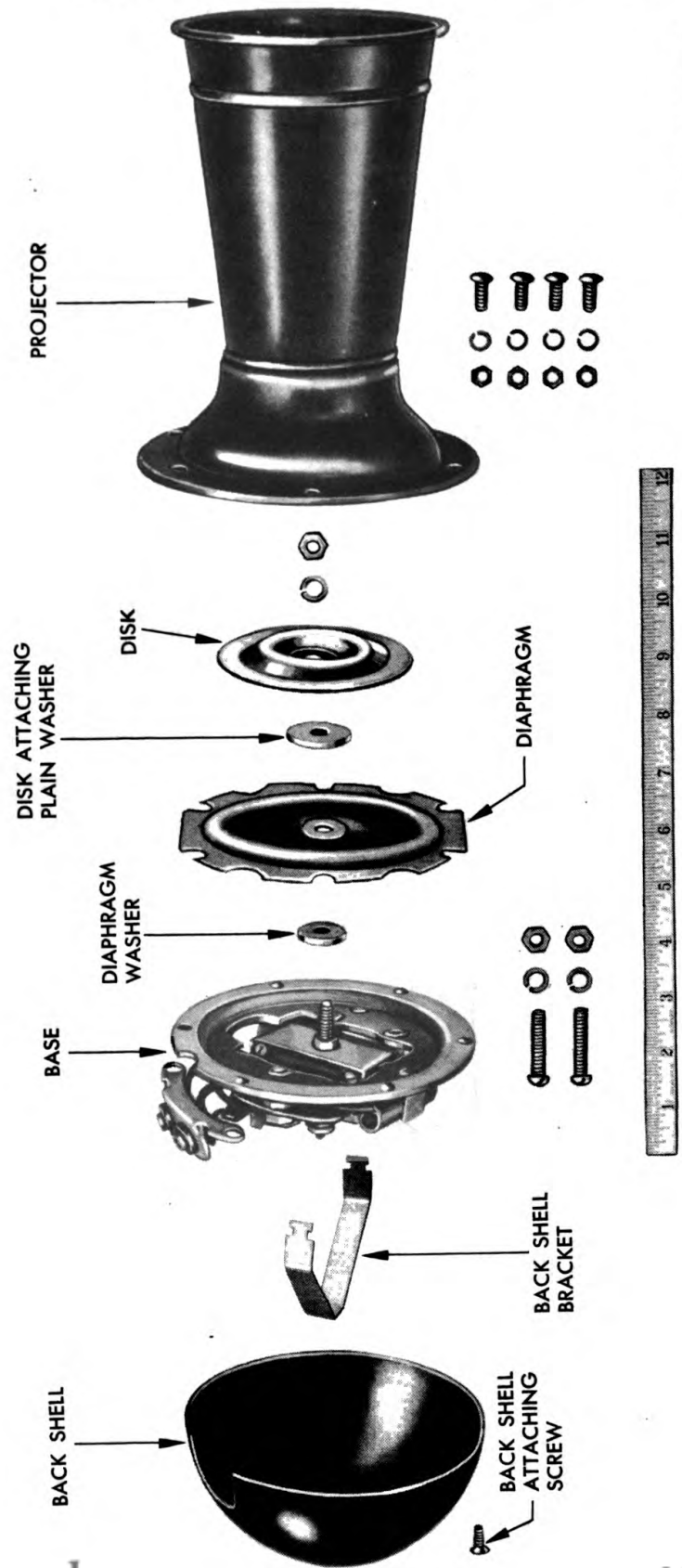


Figure 197—Horn, Disassembled

HORNS

its magnetism, allowing the armature to return to its original position. This action is repeated very rapidly, causing the diaphragm to be vibrated so that the warning signal is produced.

184. CLEANING, INSPECTION, AND TEST.

- a. **Cleaning.** Do not steam-clean or dip-clean the horn since this will damage the points and winding. Clean by wiping with a cloth.
- b. **Inspection.** Inspect for broken or loose parts.
- c. **Test.** Blow horn to see if warning signal is adequate and normal.

185. DISASSEMBLY (fig. 197).

- a. Remove screw and back shell.
- b. Remove back shell supporting bracket by expanding slightly.
- c. Remove two long screws, four short screws, and five lock washers and separate base from projector.
- d. Take off lock and adjusting nuts, if they require replacement.
- e. Unsolder and take off resistor or condenser, if it requires replacement.
- f. Take off terminal assembly by unsoldering leads, if it requires replacement.
- g. Take off nut, lock washer, plain washer, disk, diaphragm washer, diaphragm, and diaphragm washer if the diaphragm or other part needs replacement.

186. CLEANING, INSPECTION, REPAIR, AND TEST OF PARTS.

- a. Inspect screws and nuts for battered or crossed threads. Note condition of soldered connections and resolder using a rosin flux, if necessary. Replace diaphragm if it is cracked or broken. Note tightness of assembling nuts on base holding the horn parts together and tighten if loose. Note contact point condition and clean with a fine file, if excessively dirty or burned. Test condenser (if present) on condenser tester.

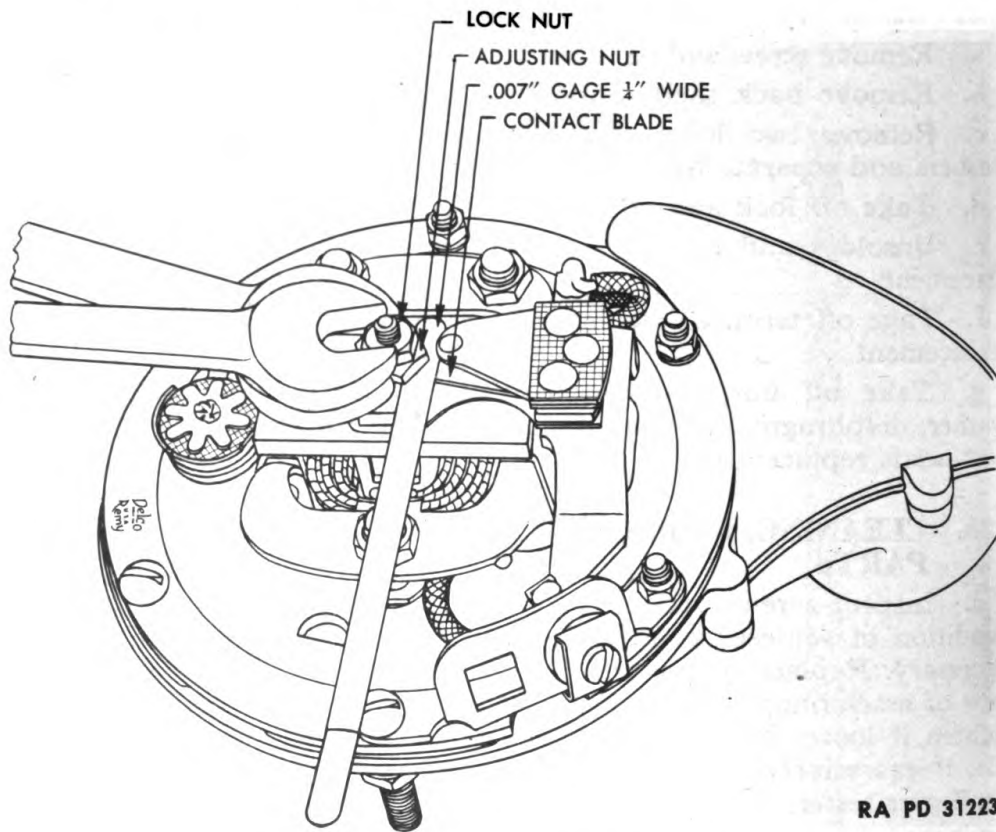
187. ASSEMBLY.

- a. Replace diaphragm washer, diaphragm, diaphragm washer (turn radius on washers toward diaphragm), disk, plain washer, lock washer, and nut if they have been removed.
- b. Replace resistor or condenser and solder leads (rosin flux).
- c. Install lock and adjusting nuts, if they have been removed.
- d. Attach base to projector with two long screws, four short screws, and five lock washers. Drain-hole in projector must be located at bottom after horn is remounted on vehicle.
- e. Test and adjust horn (pars. 186 and 188).
- f. Put back shell supporting bracket in place and attach back shell with screw.

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ELECTRICAL EQUIPMENT (DELCO-REMY)**

188. ADJUSTING HORN (fig. 198).

a. Connect horn in series with a battery and a switch. Insert a 0.007 inch gage (not more than $\frac{1}{4}$ inch wide), between the adjusting nut and contact blade or contact blade insulator (fig. 198). Do not allow gage to touch contact points. Loosen lock nut and turn adjusting nut down until the horn will not blow. Then back adjusting nut off less than $\frac{1}{10}$ turn and tighten lock nut. Check to see if horn will blow. If it does not, back off adjusting nut again (less than $\frac{1}{10}$ turn) tighten lock nut and retest horn. Repeat until horn barely blows. Remove gage and replace cover. Horn tone will now be satisfactory.



RA PD 312231

Figure 198—Adjusting Horn

CHAPTER 6
MISCELLANEOUS (Cont'd)

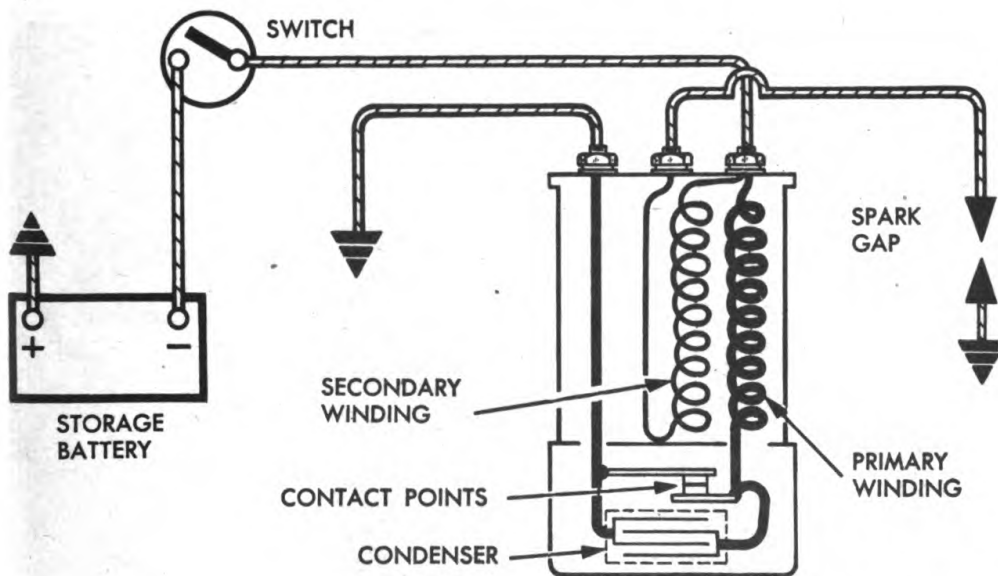
Section V

BOOSTER COILS

	Paragraph
Construction and function	189
Cleaning, inspection, test, and repair	190
Disassembly	191
Assembly	192
Test and adjust	193

189. CONSTRUCTION AND FUNCTION.

a. Booster coils are designed to produce a series of high voltage surges in rapid succession. These high voltage surges may be used to ignite a spray of oil in the intake manifold of a Diesel engine for easier starting, or to improve the spark obtained during initial starting with magneto ignition. The booster coil contains primary and secondary windings, the primary being connected in series with a set of contact points. Closing the booster coil switch causes current

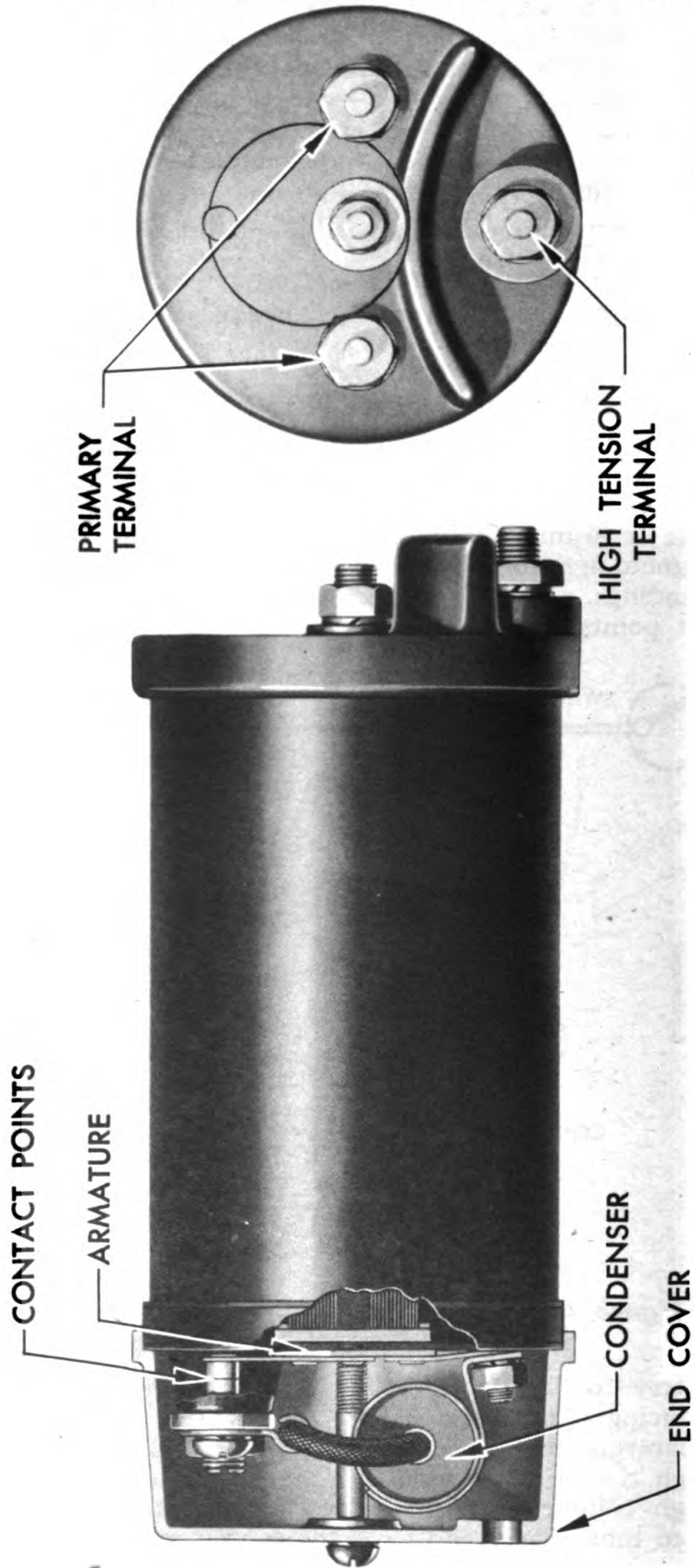


RA PD 312212

Figure 199—Booster Coil Wiring Circuit

from the battery to flow through the contact points and primary winding, producing a magnetic field. This attracts the booster coil armature, separating the contact points and stopping the flow of current through the primary winding. The magnetic field collapses, inducing a high voltage surge in the coil secondary and permitting the armature to move away and close the contact points. This cycle

**ORDNANCE MAINTENANCE
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RA PD 312213

Figure 200—Sectional View of Booster Coil

RA PD 312214

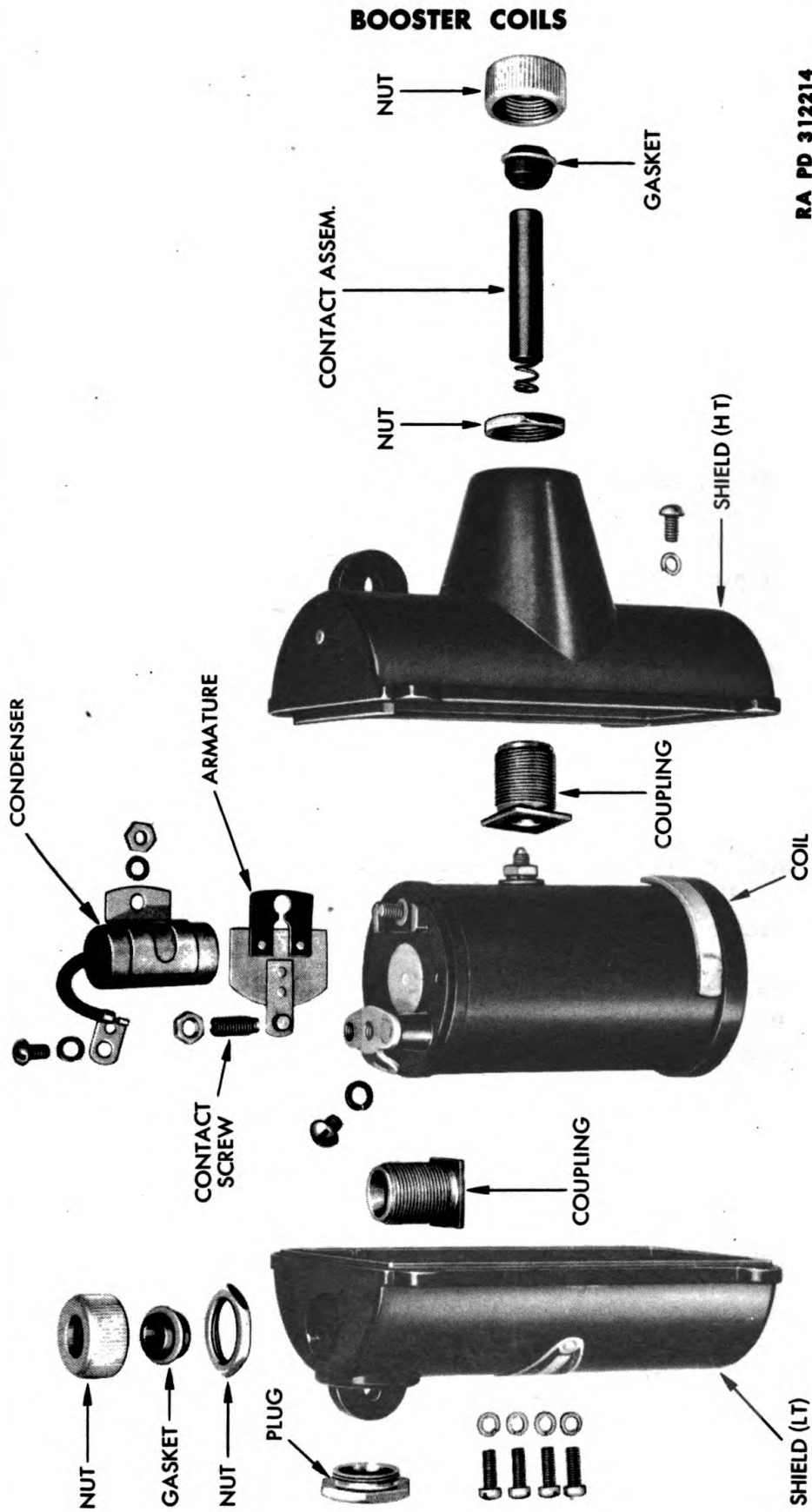


Figure 201—Booster Coil, Disassembled

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

is repeated very rapidly, causing a stream of high voltage surges to be produced in the coil secondary. In general, all booster coils are of similar construction although some are shielded (fig. 201).

190. CLEANING, INSPECTION, TEST, AND REPAIR.

a. Refer to paragraph 170. Check contact points. If they are dirty or burned, clean them with a fine file. Adjust as necessary (par. 193).

191. DISASSEMBLY (fig. 201).

a. From high tension terminal, remove nut, seal, insulator, spring, and nut.

b. Remove ground screw.

c. Remove four screws and lock washers, separate shield halves and remove coil.

d. Separate primary lead insulator by removing nut, seal, nut, and shield coupling.

e. Remove the condenser and armature from coil by removing nut, screw, and washers.

f. Remove lock nut and contact screw by unsoldering and unscrewing, if they require replacement.

192. ASSEMBLY.

a. Install lock nut and contact screw.

b. Install condenser and armature. Adjust contact screw and solder (par. 193).

c. Assemble primary lead insulator with coupling, nut, seal, and nut.

d. Install coil in shield and secure with ground screw, four screws, and lock washers.

e. Assemble high tension terminal parts.

193. TEST AND ADJUST.

a. Adjust contact point opening, if necessary, by unsoldering and loosening lock nut and contact screw and turning screw in or out as required. Tighten nut and solder nut and screw to bracket. No other adjustment is possible. Coil must test correctly in accordance with coil tester manual.

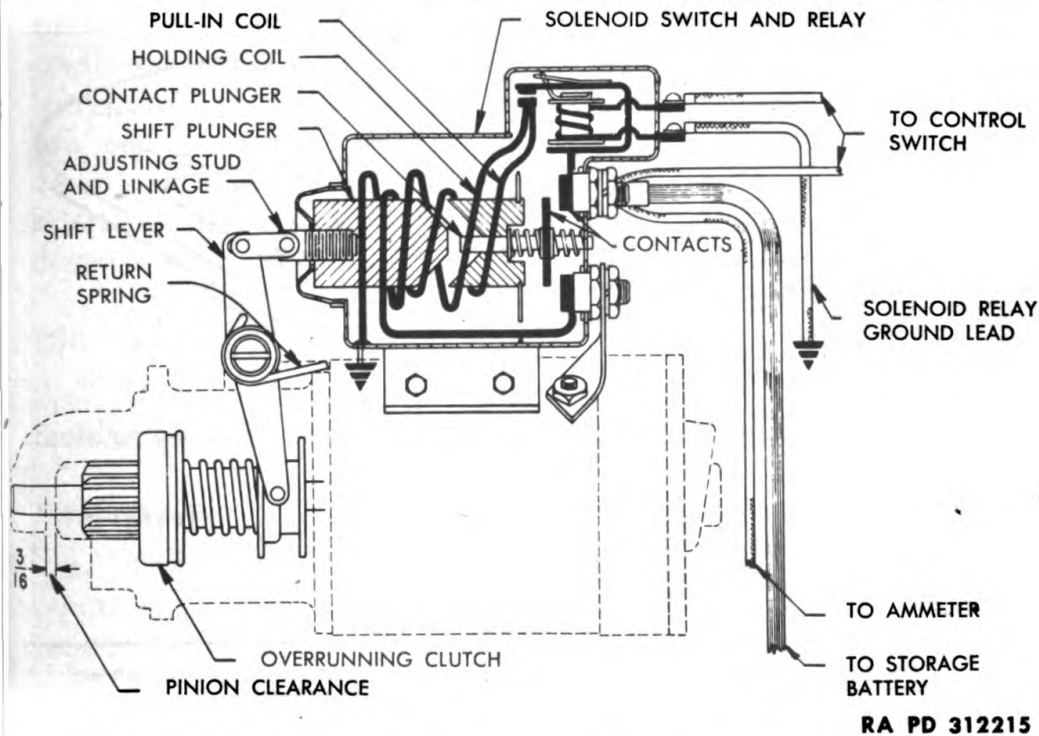
CHAPTER 6
MISCELLANEOUS (Cont'd)

Section VI
RELAYS

	Paragraph
Construction and function	194
Relay check and adjustment	195
Relay specifications	196

194. CONSTRUCTION AND FUNCTION.

a. Relays are similar in construction to the cut-out relays used in connection with generators (par. 41) and are used to electrically open and close circuits. Horn relays connect horns through the relay points to the battery; lighting relays connect the lights through the



RA PD 312215

Figure 202—Solenoid Relay and Solenoid Wiring Circuit

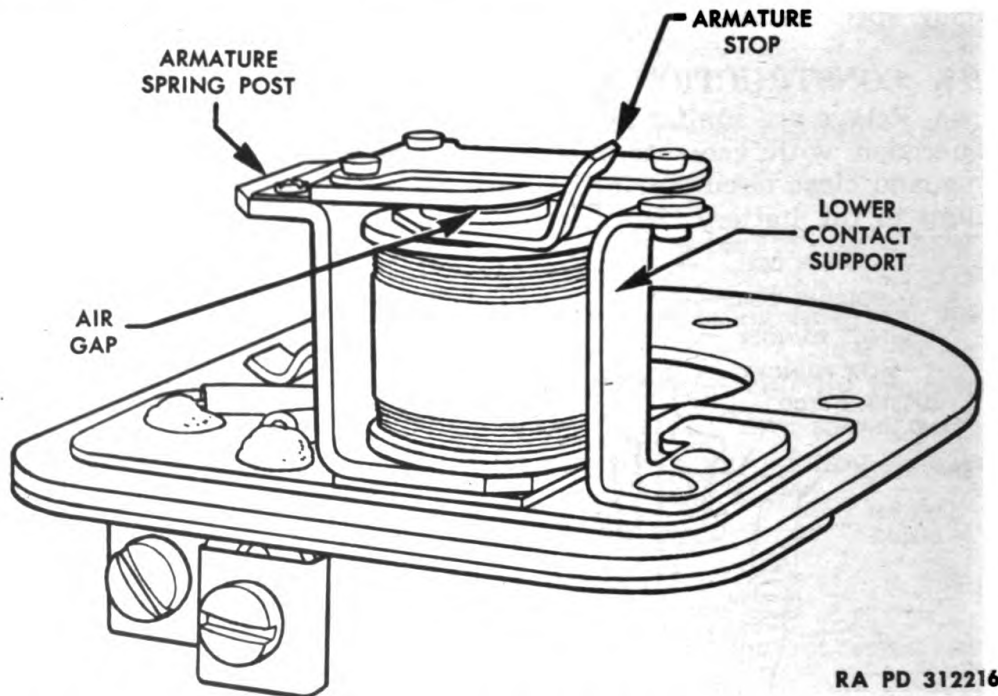
relay points to the battery; solenoid relays connect the solenoid through the relay points to the battery. In each case, extra wiring is eliminated and a more direct connection is possible with the battery so that less voltage drop is obtained. All relays are adjusted in a similar manner. No disassembly is possible; any defect requires complete relay replacement.

195. RELAY CHECK AND ADJUSTMENT.

a. Connect relay in series with a battery and a variable resistance. Apply increasing voltage, and note relay closing voltage. Adjust as follows:

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

- (1) **AIR GAP.** Measure with points closed, and adjust by bending the lower contact support.
- (2) **POINT OPENING.** Check with points open, and adjust by bending the armature stop.
- (3) **CLOSING VOLTAGE.** Adjust by bending armature spring post. Increasing spring tension increases closing voltage.



RA PD 312216

Figure 203—Solenoid Relay, Showing Points of Adjustment

196. RELAY SPECIFICATIONS.

Relays	Air Gap	Point Opening	Closing Voltage
1116755	0.015	0.020	7.0-7.5
1116775	0.015	0.025	2.75-4.0
1116781	0.015	0.025	6.0-8.0
1116812	0.010	0.020	3.0-4.0
1116817	0.015	0.020	8.0-10.0
1116818	0.020	0.030	6.0-8.0
1116833	0.008	—	8.0 Min.
1116836	0.012	0.033	15.0-18.0
RELAY OR SOLENOID			
1118112*	0.018	0.030	3.0-4.0
1118113	0.015	0.025	7.0-9.0

*Armature seals to core 5.25 volts maximum (minimum of 1 volt above closing voltage). Points open 3.0 volts maximum after sealing.

CHAPTER 6
MISCELLANEOUS (Cont'd)

Section VII

FILTERS AND SHIELDING

	Paragraph
Construction and function	197
Disassembly	198
Tests	199

197. CONSTRUCTION AND FUNCTION.

a. Filters and shielding are designed to eliminate radio interfering factors broadcast from the various electrical units and wires in the electrical system. Most filters and shields are of a simple nature. One application uses an apparatus box which contains not only the current and voltage regulators for the engine generators (there being two engines on the application) but also various filters. Several variations of this apparatus box have been used; one will be considered below. Each apparatus box contains, inside the cover, a wiring diagram which supplies details of the connections.

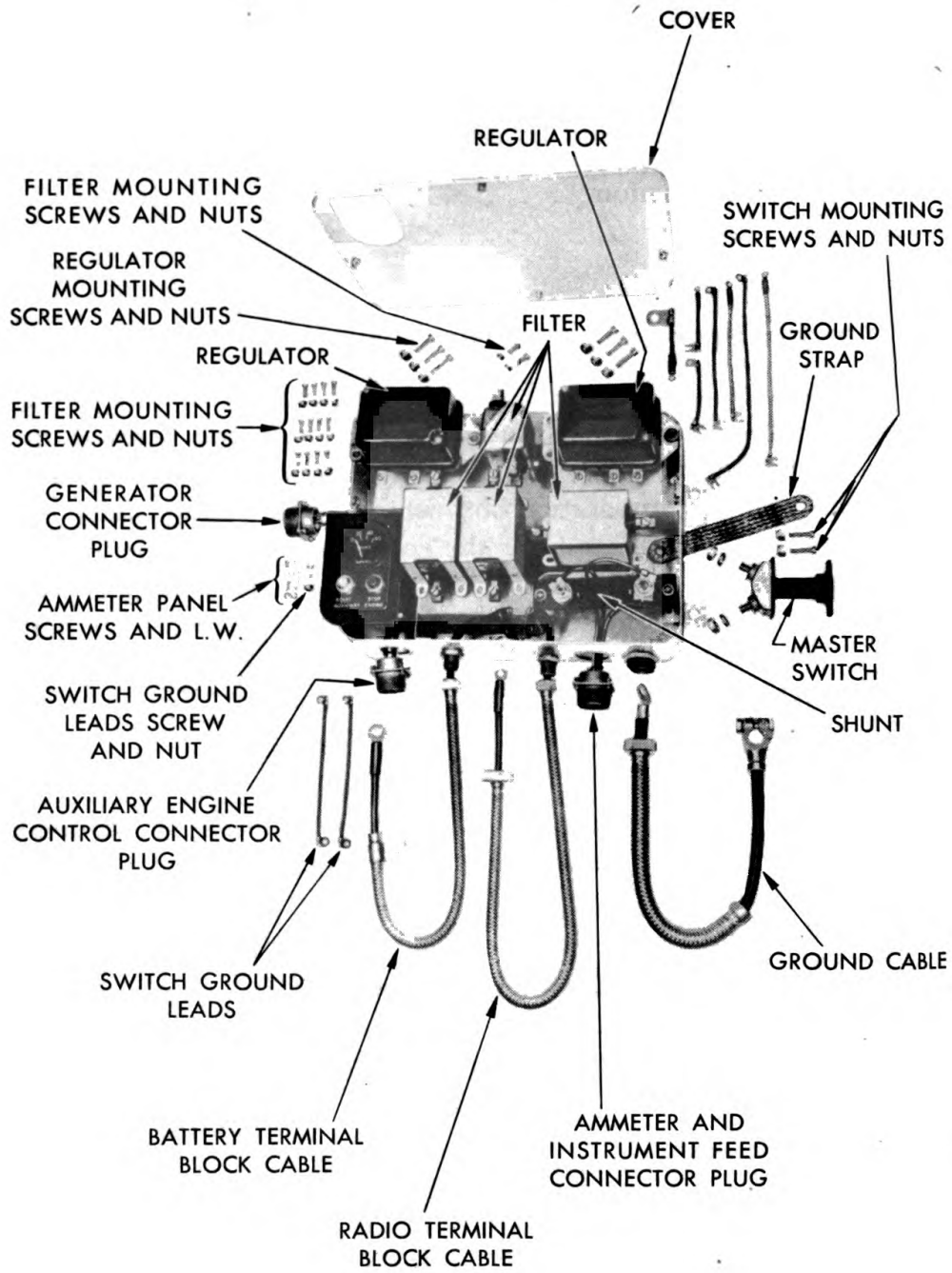
198. DISASSEMBLY.

a. Remove filters, regulators, switches, and leads as required, making necessary corrections, repairs, and replacements.

199. TESTS.

a. Test filters on condenser tester for capacity and with test points (fig. 12) for continuity. Test switches (par. 172). Test regulators in accordance with instructions supplied in chapter 3, according to type of regulator.

**ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)**



RA PD 312217

Figure 204—Apparatus Box and Components Partially Disassembled

RA PD 312218

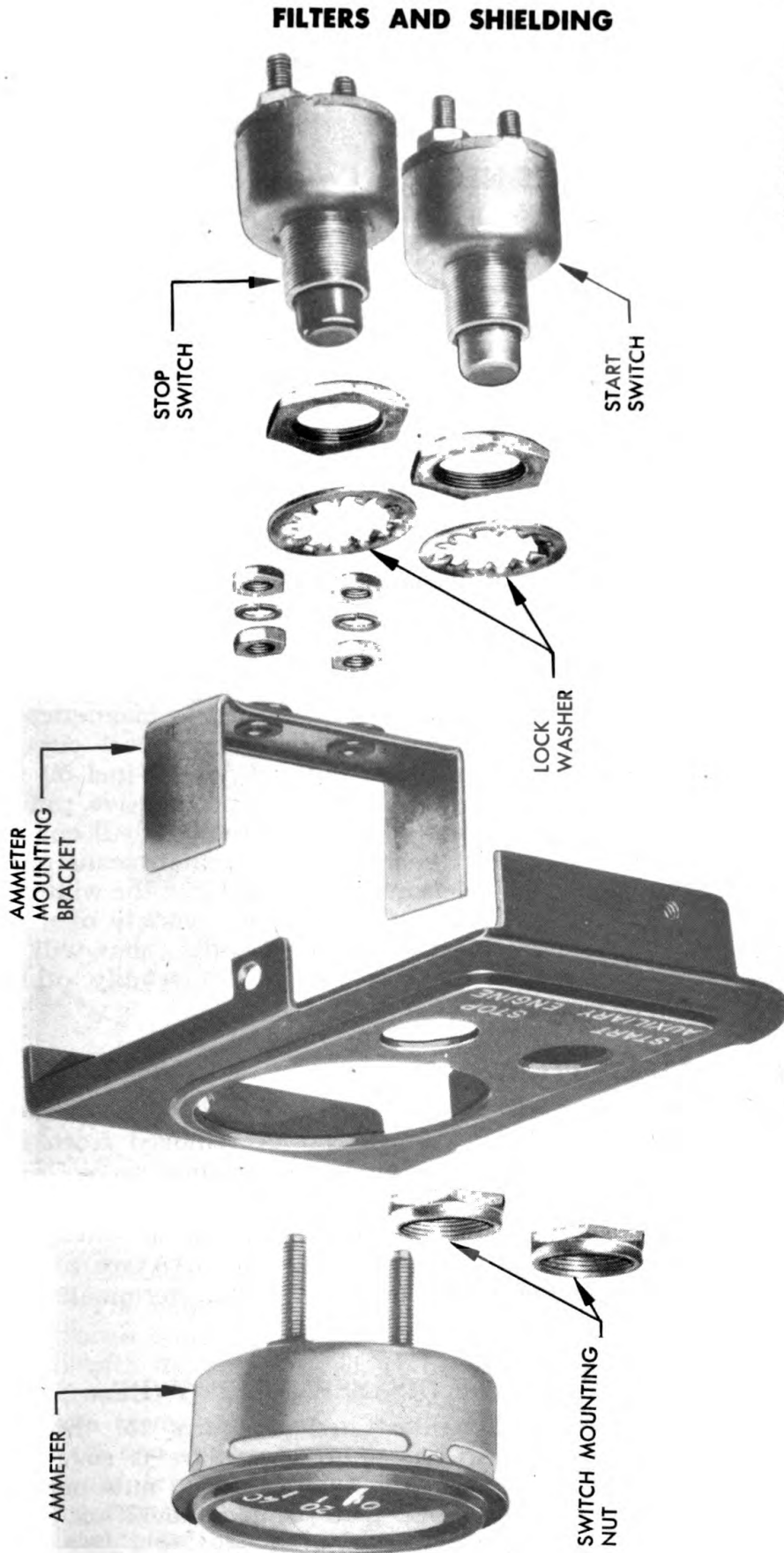


Figure 205—Disassembled View of Auxiliary Engine Control in Apparatus Box

ORDNANCE MAINTENANCE
ELECTRICAL EQUIPMENT (DELCO-REMY)

CHAPTER 6
MISCELLANEOUS (Cont'd)

Section VIII

MAGNETIC SWITCHES AND SOLENOIDS

	Paragraph
Construction and function	200
Magnetic switch	201
Magnetic switch of disassembleable type	202
Solenoid switch	203
Solenoid switch with shielded terminal	204
Solenoid with solenoid relay	205
Solenoid	206
Magnetic switch and solenoid test specifications	207

200. CONSTRUCTION AND FUNCTION.

a. Magnetic switches and solenoids are designed to magnetically perform some mechanical job such as close an electrical circuit, operate a bomb release rack, fire a gun, shut off flow of fuel oil for stopping a Diesel engine, or shift the cranking motor drive pinion into mesh with the engine flywheel for engine cranking. All consist of a winding or windings that are energized by external means from the battery. This causes a movable core to be pulled into the winding, producing the action outlined above. A considerable variety of magnetic switches and solenoids are in use, typical applications will be considered below. Some are subject to only slight disassembly, others can be completely disassembled.

201. MAGNETIC SWITCH.

a. One type magnetic switch (fig. 206), cannot be disassembled. Only the outer nuts and lock washers can be removed from the terminals. If the inner nuts are loosened, the terminal screws may turn, causing the leads inside the switch to break off so the switch is ruined. The switch is tested by applying an increasing voltage to see what voltage is required to operate the switch. A set of test points (fig. 12) connected across the main switch terminals will indicate closing of the switch.

202. MAGNETIC SWITCH OF DISASSEMBLED TYPE.

a. The type magnetic switch illustrated in figures 207 through 209 can be disassembled. The disassembly procedure is easy and obvious. Removing the three screws, lock washers, and nuts permits detachment of shell from terminal plate and removal of other internal parts.

MAGNETIC SWITCHES AND SOLENOIDS

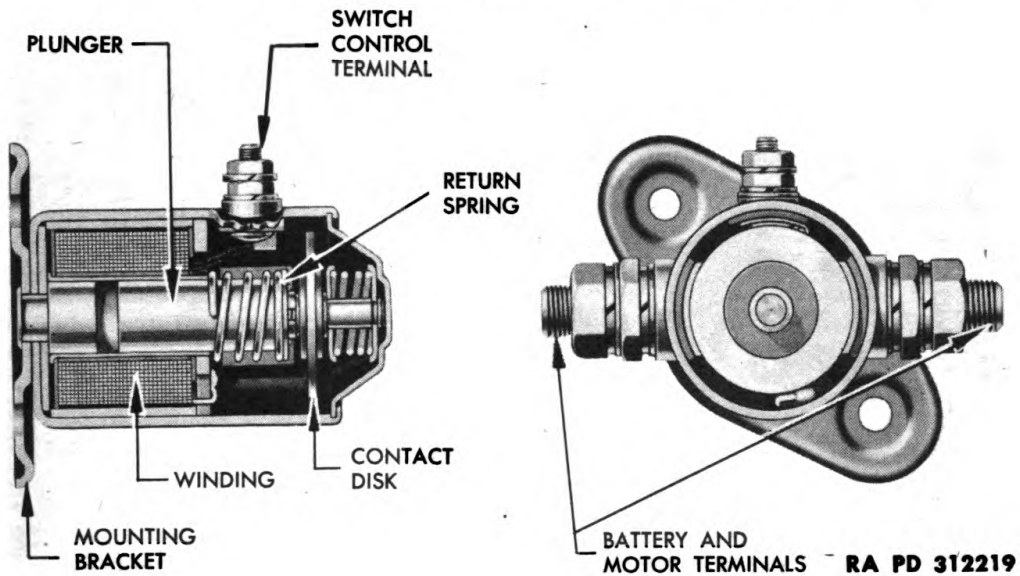


Figure 206—Sectional View of Magnetic Switch

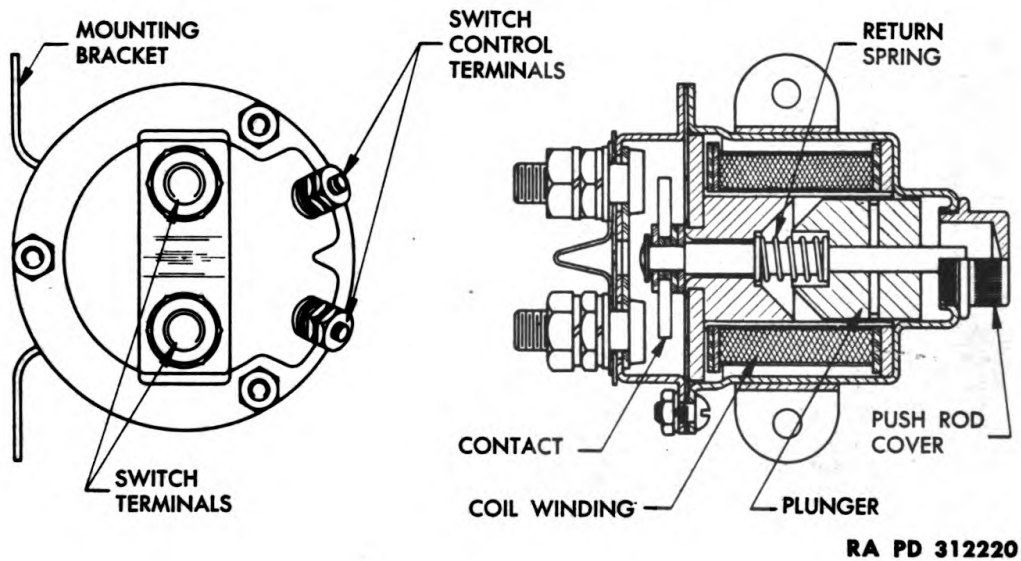
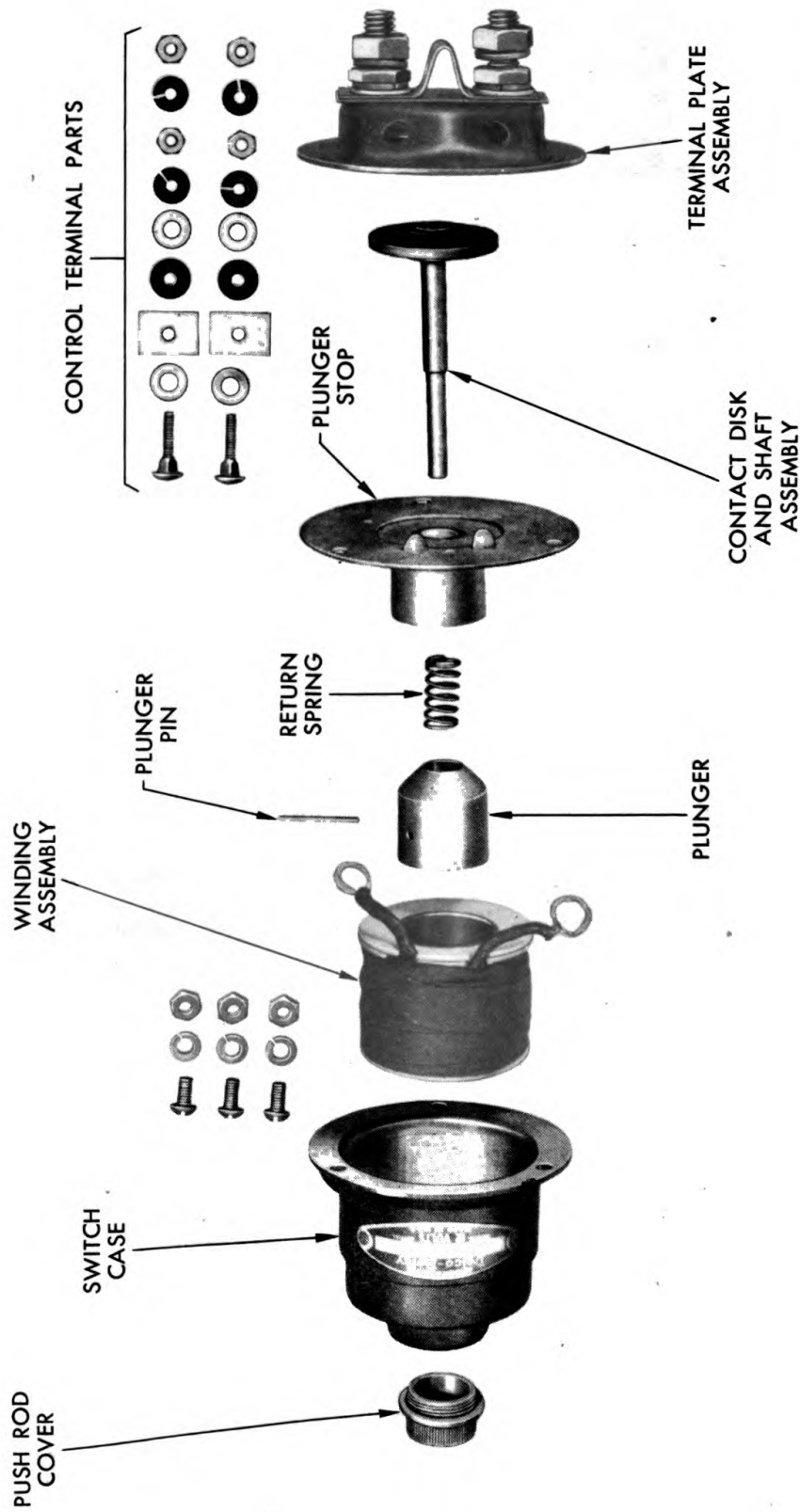


Figure 207—Sectional View of Magnetic Switch

203. SOLENOID SWITCH.

a. The solenoid switch illustrated in figures 210 through 212 is used on a cranking motor and not only shifts the drive pinion into mesh with the engine flywheel, but it also closes the circuit between the cranking motor and battery, allowing cranking. To disassemble, remove cover attaching screws and detach cover. Unsolder leads, take off two screws, and detach terminal plate assembly. Detach the U-shaped retainer, contact disk, washer, spring, washer, U-shaped spring retainer, and spring from the push rod. Disassemble the terminal plate assembly by removing nuts, washers, lock washers,

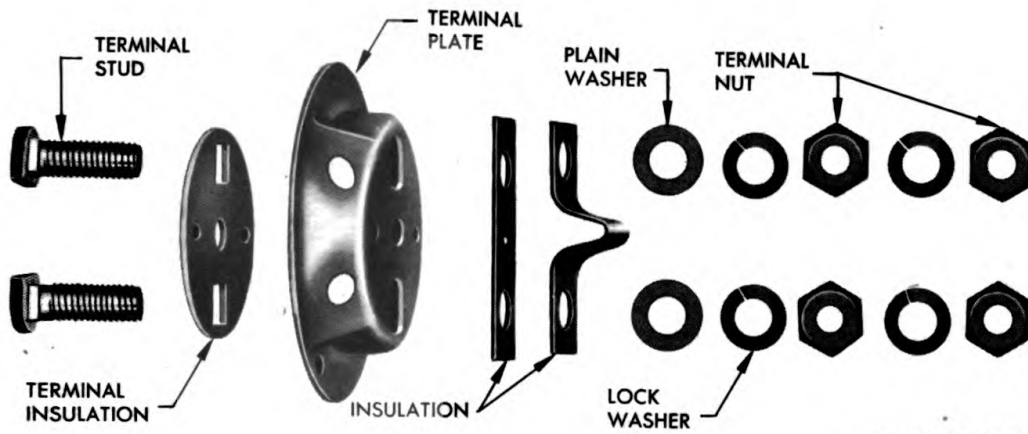
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RA PD 312221

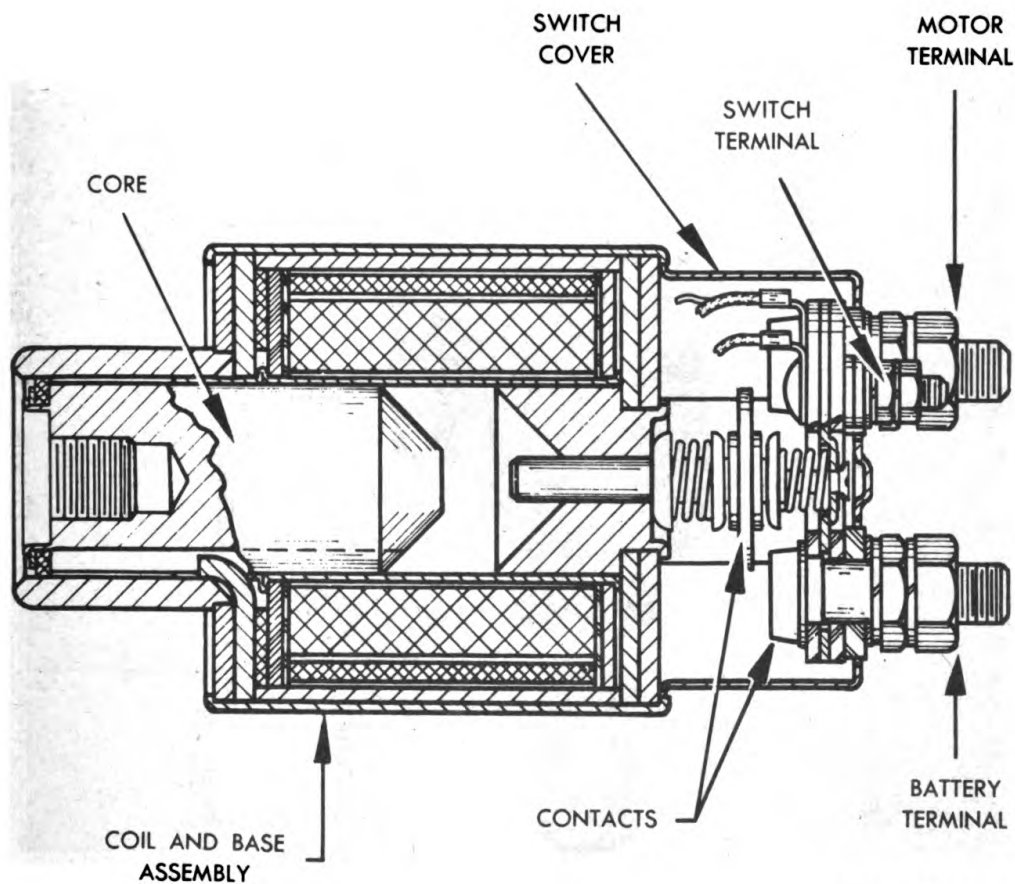
Figure 208—Disassembled View of Magnetic Switch Shown in Figure 207

MAGNETIC SWITCHES AND SOLENOIDS



RA PD 312222

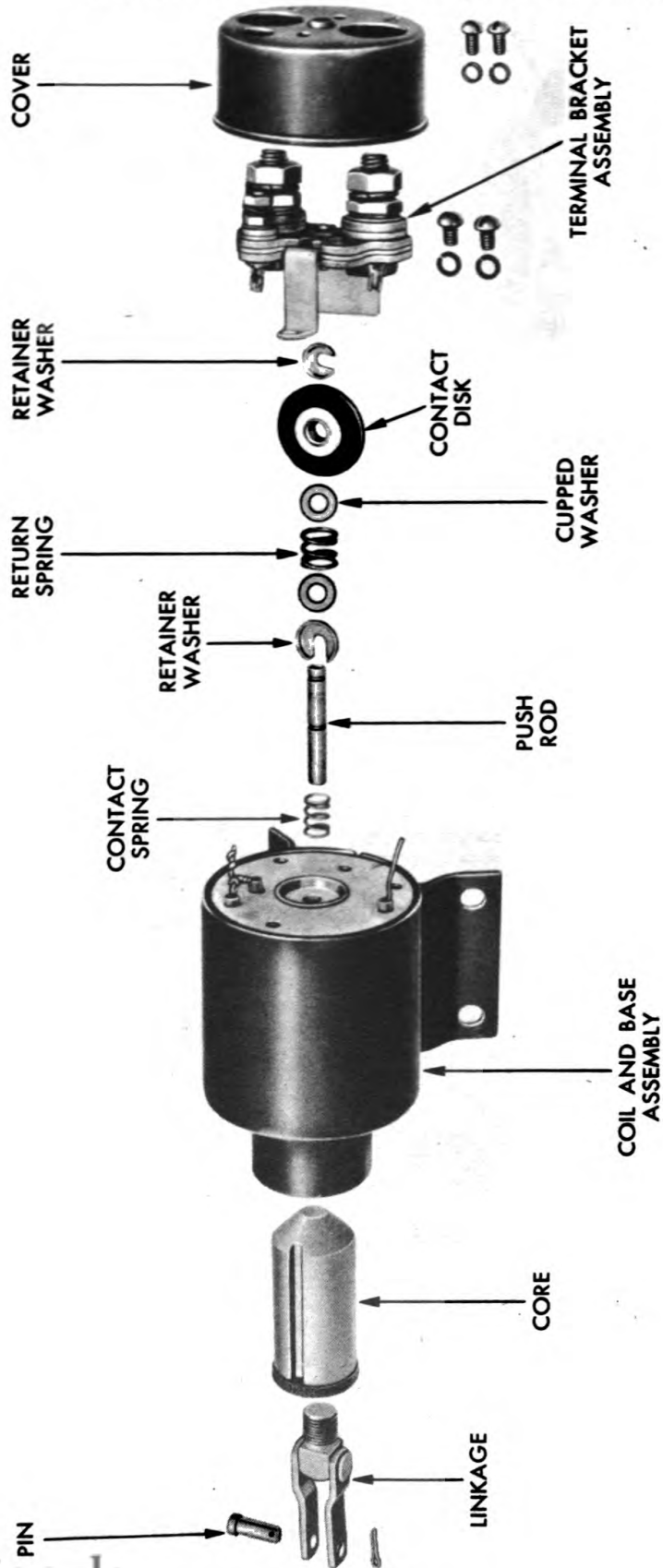
Figure 209—Disassembled View of Terminals of Magnetic Switch Shown in Figure 207



RA PD 312223

Figure 210—Sectional View of Solenoid Switch

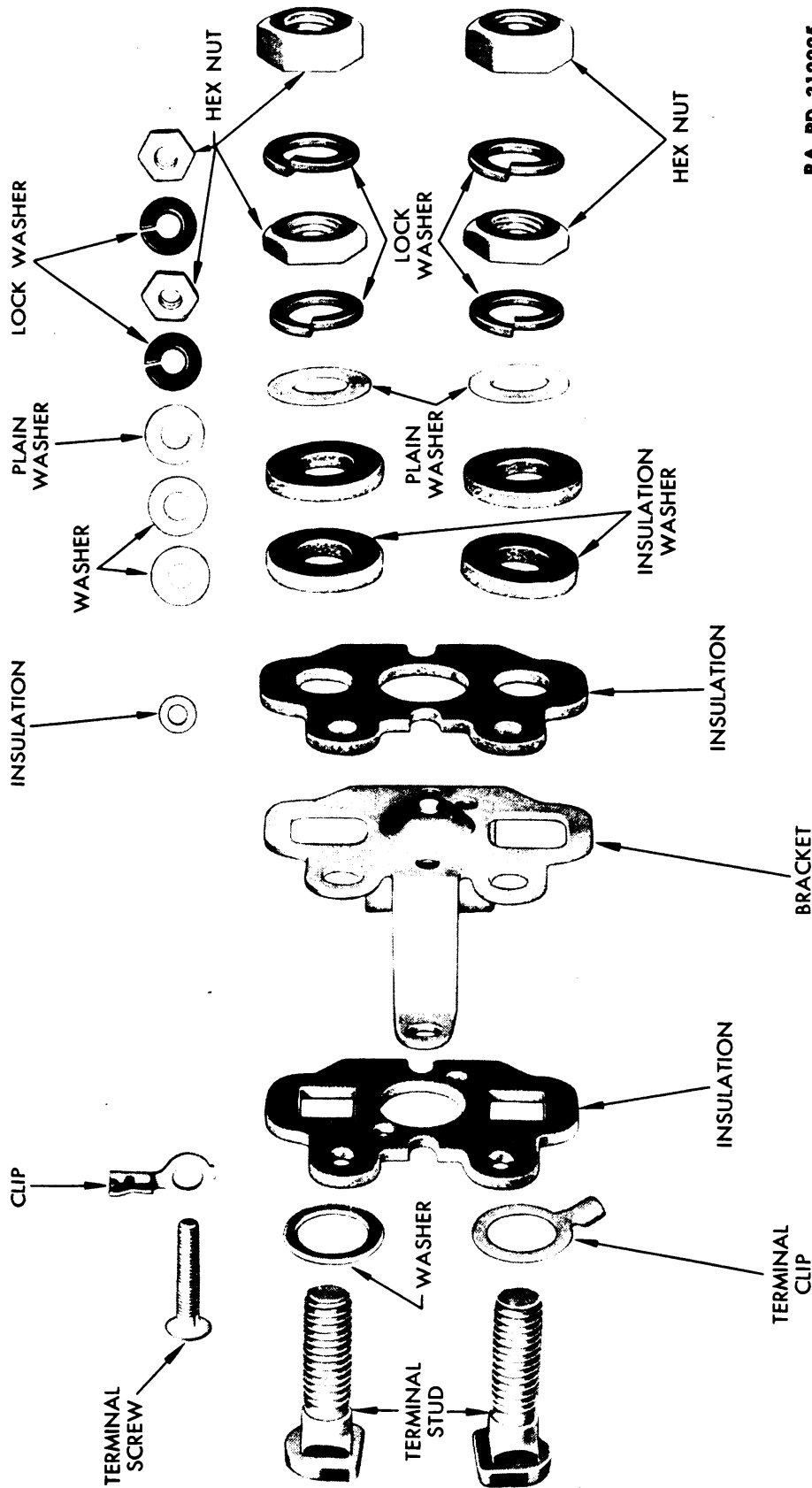
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RA PD 312224

Figure 211—Solenoid Switch, Disassembled

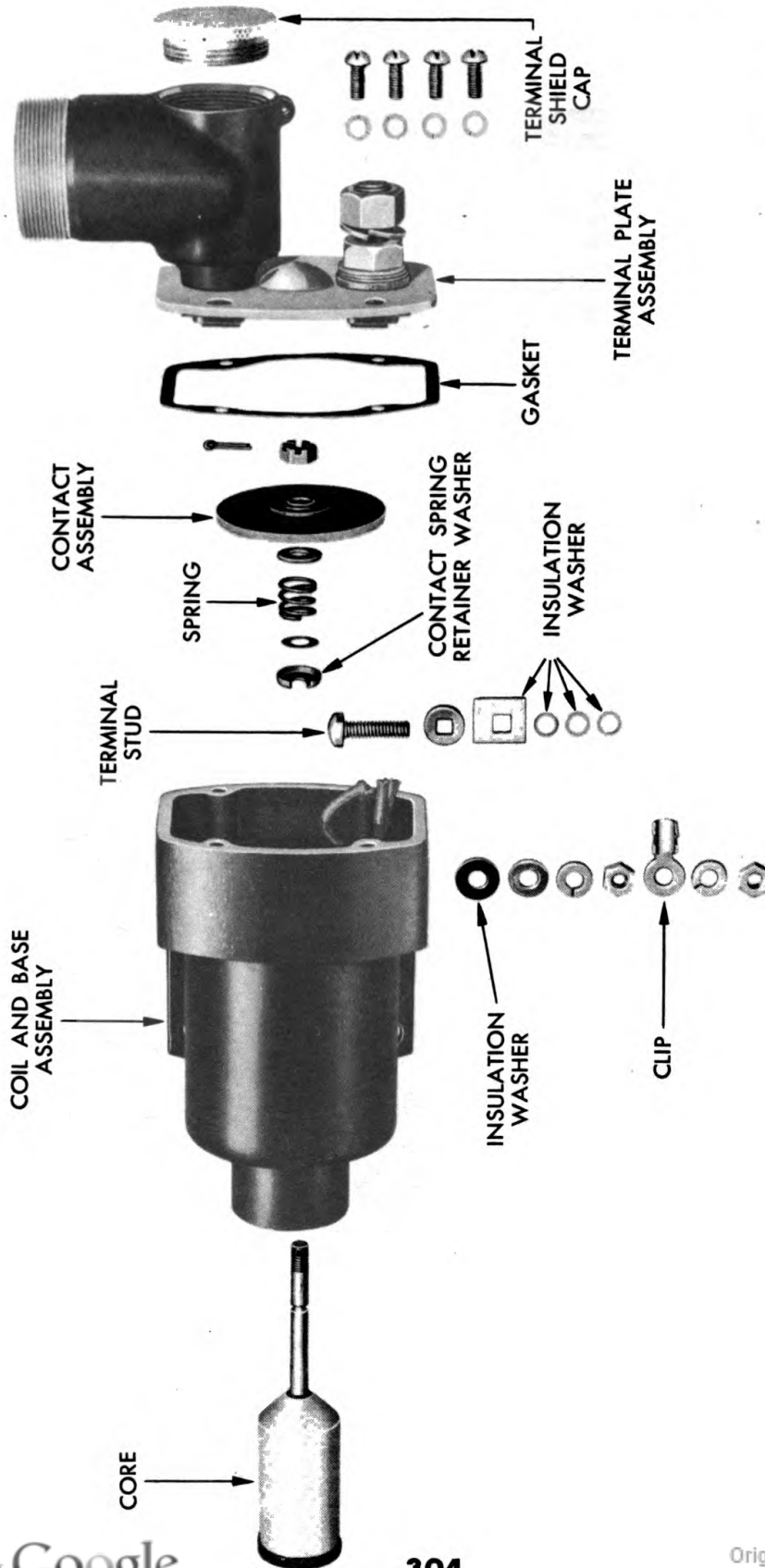
MAGNETIC SWITCHES AND SOLENOIDS



RA PD 312225

Figure 212—Terminal Plate Assembly of Solenoid Switch, Disassembled

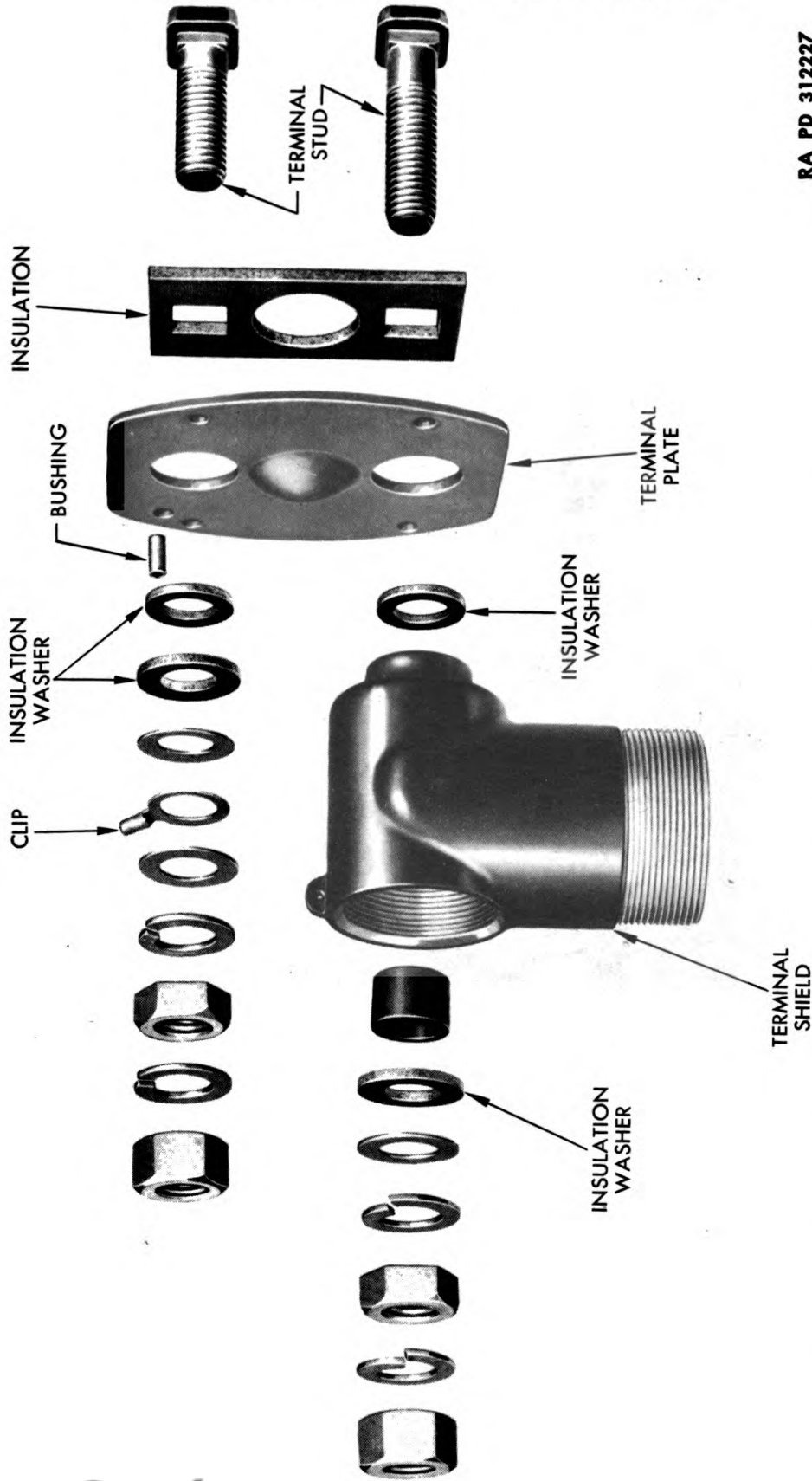
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RA PD 312226

Figure 213—Heavy-duty Cranking Motor Solenoid Switch, Disassembled

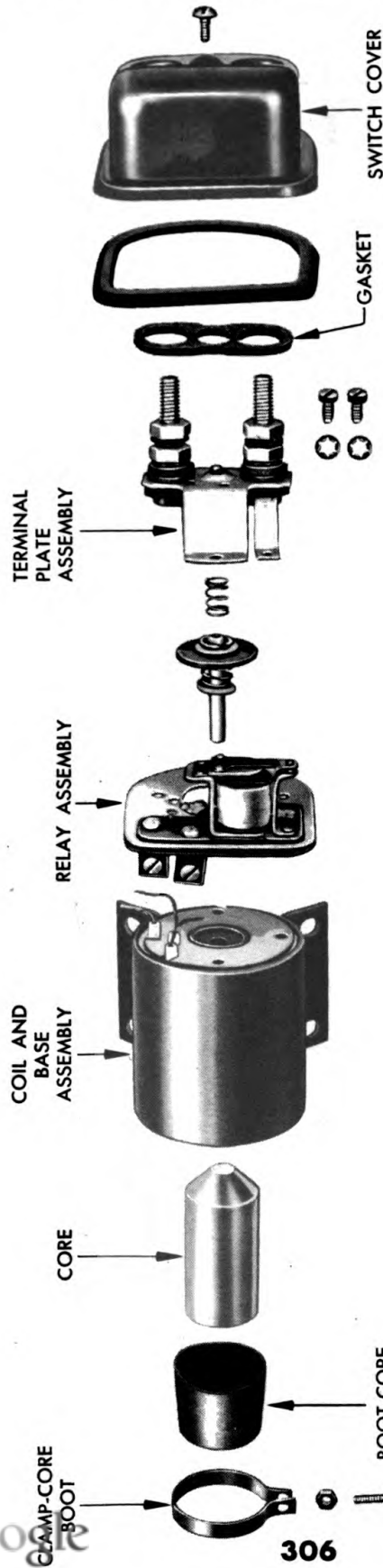
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Figure 214—Disassembled View of Terminal Plate Assembly for Solenoid Switch Shown in Figure 213

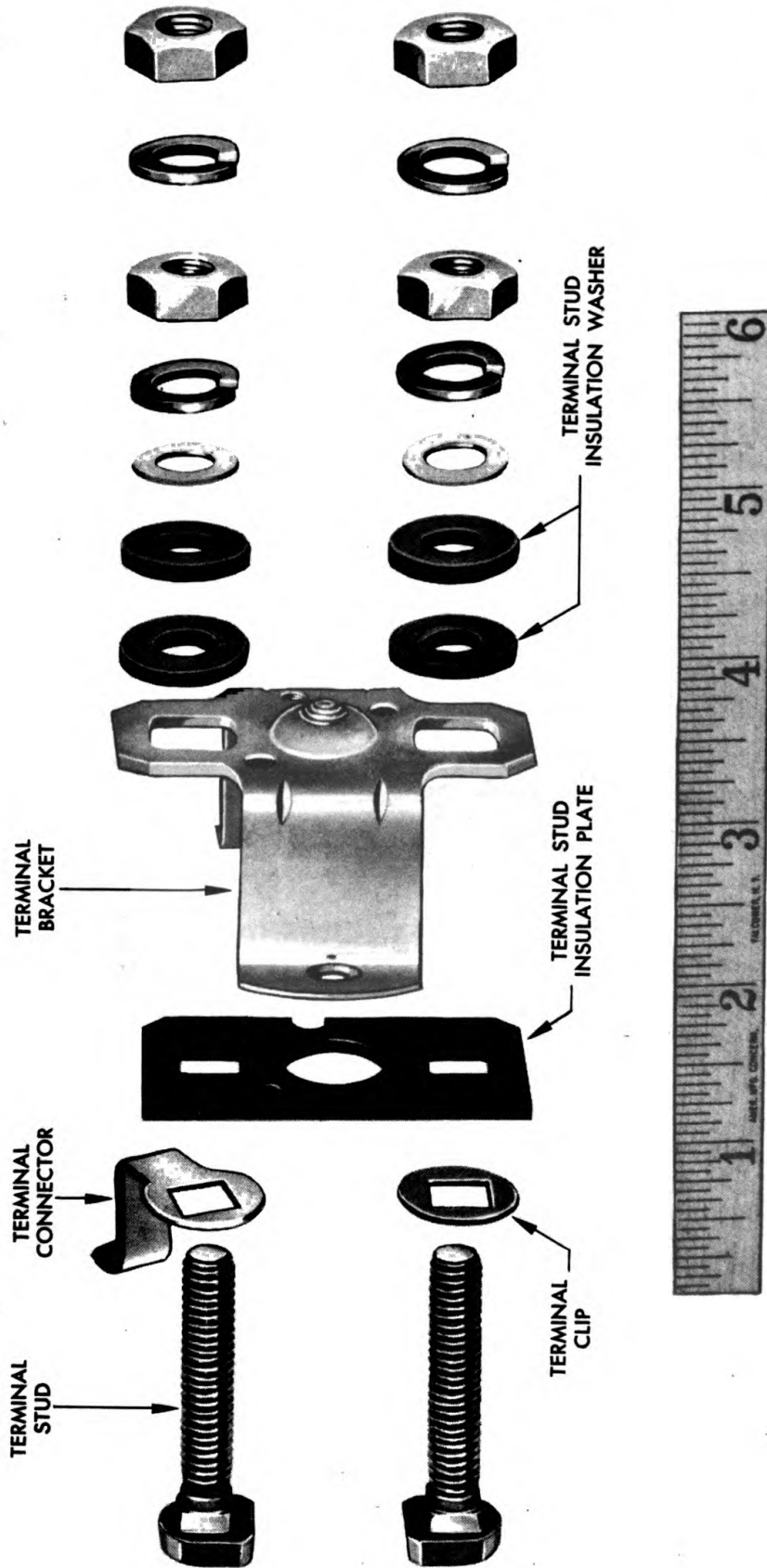
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RA PD 312228

Figure 215—Cranking Motor Solenoid Relay with Solenoid Relay, Disassembled

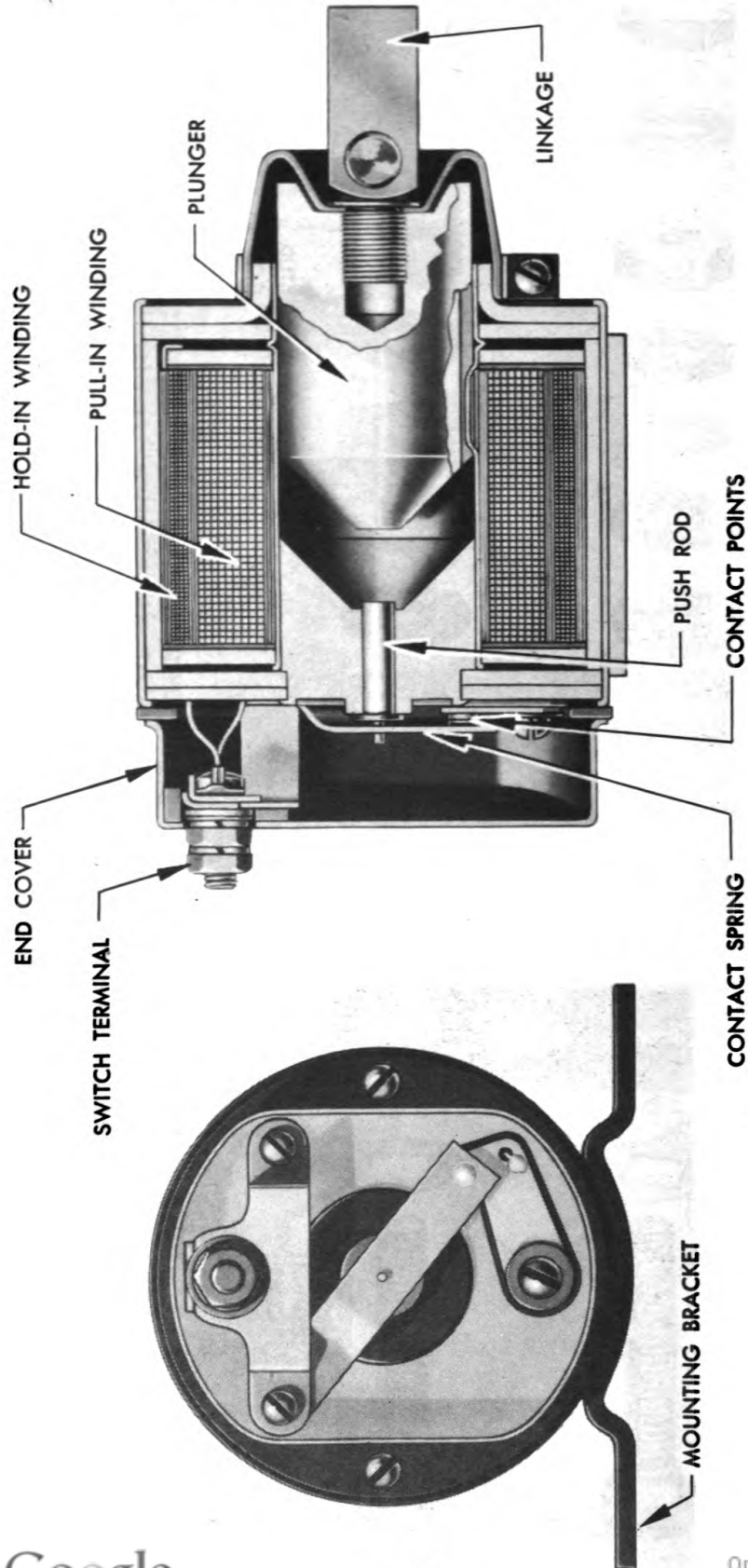
MAGNETIC SWITCHES AND SOLENOIDS



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Figure 216—Disassembled View of Terminals of Solenoid Shown in Figure 215

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RA PD 312230

Figure 217—Sectional View of Fuel Shut-off Solenoid

MAGNETIC SWITCHES AND SOLENOIDS

and insulators from terminal screws. Assemble by reversing the above disassembly procedure.

204. SOLENOID SWITCH WITH SHIELDED TERMINAL.

a. The solenoid switch illustrated in figures 213 and 214 is similar to switch shown in figures 210 through 212 except that the solenoid contact housing is different and a solenoid terminal is shielded. On reassembly, adjust contact disk by means of castellated nut so face of disk is $1\frac{1}{32}$ inch below edge of housing with movable core in retracted position. Fill bushing in terminal plate through which lead passes with Permatex No. 1 after assembly is complete.

205. SOLENOID WITH SOLENOID RELAY (figs. 215 and 216).

a. This type solenoid includes a solenoid relay and requires a slightly different disassembly procedure from other solenoids previously considered. Disassemble and assemble as follows:

(1) Remove nuts, lock washers, and washers from terminals. Take off cover screw, cover and gasket.

(2) Unsolder lead clip (under terminal screw), unsolder connector strap (from relay) and unsolder two leads (wrapped together) from relay frame.

(3) Assemble by reversing disassembly procedure.

206. SOLENOID (fig. 217).

a. This type solenoid is used to perform a manual job such as shutting off the fuel so the engine can be stopped. No disassembly is recommended.

207. MAGNETIC SWITCH AND SOLENOID TEST SPECIFICATIONS.

Model	Max Volts to Close*	CURRENT CONSUMPTION	
		Amps	Volts
1422 to 3	7.0	12.0-13.0	12
1451 to 3	4.7	3.1- 3.7	4
1406 to 8	10.0	1.4- 1.5	8
1459 to 61	4.7	3.1- 3.7	4
1544	10.0	1.4- 1.5	8
1568	9.0	2.4- 2.6	6
1118008	7.0	12.0-13.0	12
1118028	13.5	2.0- 2.2	12
1118044	9.0	2.4- 2.6	6
1118061†	5.0	58.0-64.0	5
1118110	4.0	12.0-13.0	12

*Room temperature.

†Air gap 0.5 inch, 90 pounds tension. Hold in winding 10.0-12.0 amperes at 5.0 volts.

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CHAPTER 7
SPECIAL TOOLS

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Special tools	208

208. SPECIAL TOOLS.

a. Maintenance Tool Sets. The tool sets available to individuals (specialists) and organizations, dependent upon the allocation in the table of equipment are listed in SNL G-27.

REFERENCES

STANDARD NOMENCLATURE LISTS.

Cleaning, preserving and lubrication materials, re-coil fluids, special oils, and miscellaneous related items	SNL K-1
Soldering, brazing and welding materials, gases and related items	SNL K-2
Electrical apparatus units and parts	SNL M-1
Electrical fittings	SNL H-4
Electrical piece material	SNL H-5
Pipe and hose materials	SNL H-6
Pipe, tubing, and hose	SNL H-7
Tools, maintenance, for repair of automotive vehicles	SNL G-27 Vol. 1
Interchangeability chart of ordnance maintenance tools for combat vehicles	SNL G-27 Vol. 2
Ordnance maintenance sets	SNL N-21
Tool sets for ordnance service command, automotive shops	SNL N-30
Tool sets—motor transport	SNL N-19
Current Standard Nomenclature Lists are listed above. An up-to-date list of SNL's and other Ordnance Publications is maintained in the Index to Ordnance Publications	OFSB 1-1

EXPLANATORY PUBLICATIONS.

General.

List of publications for training	FM 21-6
Military motor vehicles	AR 850-15
Standard military motor vehicles	TM 9-2800

Related Technical Manuals.

Automotive electricity	TM 10-580
Basic maintenance manual	TM 38-250
Electrical fundamentals	TM 1-455

Decontamination.

Chemical decontamination materials and equipment	TM 3-220
Decontamination of armored force vehicles	FM 17-59
Defense against chemical attack	FM 21-40

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